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MEDICAL LEADERS

SAMUEL W. LAMBERT, M.D.
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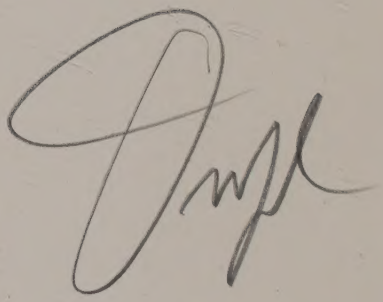

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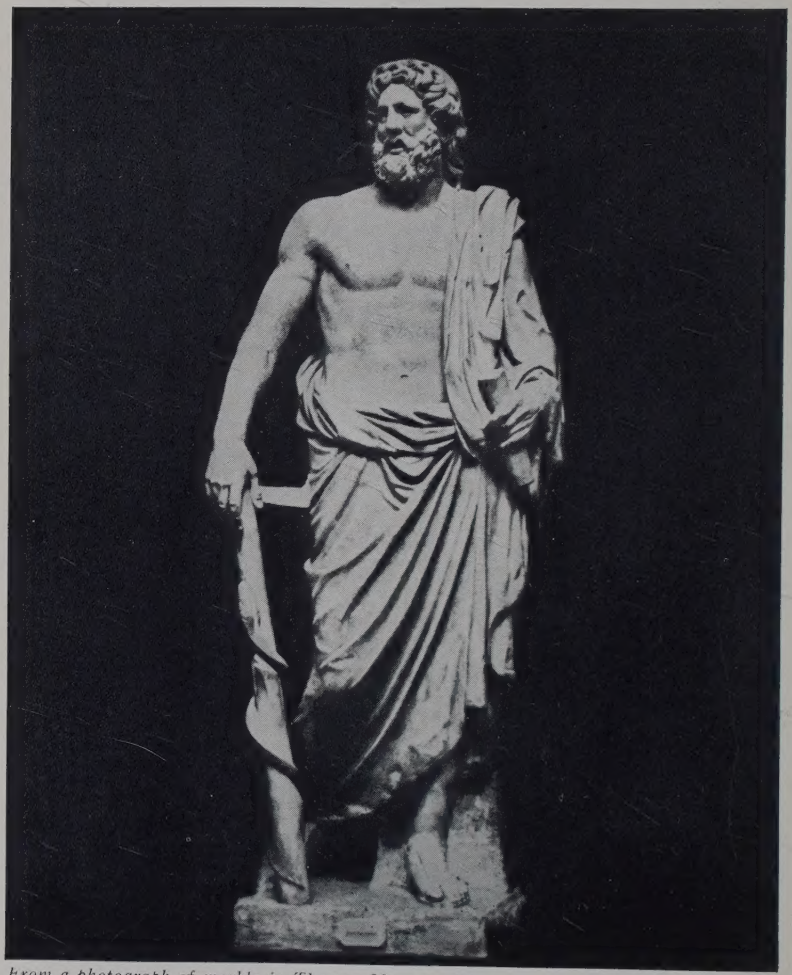
MEDICAL LEADERS



From a photograph of marble in Thermæ Museum, Rome, in the Collection of The New York Academy of Medicine

Figure I

ÆSCULAPIUS

Medical Leaders

From Hippocrates to Osler

By

Samuel W. Lambert, M.D.
and
George M. Goodwin, M.D.

Illustrated

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This book is inscribed to the memory of

GEORGE S. HUNTINGTON, M.D.

a great anatomist of his time whose studies
of Vesalius and the medical history
of the sixteenth century made
him a noted teacher of
his science

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PREFACE

THIS short resumé of the history of medicine is an attempt to follow the sequence of events from the remarkable medicine produced by Greek culture down to the active and progressive medical science of the civilization of the twentieth century. The evolution from the explanation of illness by the presence of demons, by witchcraft and by supernatural causes to the modern conception of the processes of disease in the body and to the accepted proof of the causation of infections and communicable diseases by living germs presents a long and devious development of an appreciation of science and natural law in the mind of man. Although the pioneers of medical thought have always been far in advance of the blind adherence of the uneducated to the soothsayings and inherited verbal traditions of their home life, the education of the crowd is still most incomplete. The majority of the human race is in the nursery of medical progress to-day and is still lagging far behind the leaders who have labored in every generation to carry the children of men to a higher plane of healthy living.

Emphasis has been laid on the most prominent leaders in this struggle for a better understanding of life, illness and death. It was impossible to mention all who have contributed to this end but it is hoped that the reader may be interested in tracing the steady flow of the stream of medicine to a more thorough

knowledge, in spite of many eddies of falsehood and many quagmires of doubt and delay. The bibliographies of ancient books, which are incomplete, are introduced to show how slender is the thread which tied the remarkable development of the schools of Greece, Alexandria and the Rome of Galen to the Renaissance of art and letters and its accompanying birth of a science of nature and of medicine in the fifteenth and sixteenth centuries. Ancient medicine has been able to hand down to modern times only a small portion of its history and of its successes.

Modern medicine is the child of the nineteenth century and has advanced to a point where no one man can know it all or practice every branch, and the growth of specialism is the inevitable result. Modern methods are under severe criticism to-day and must continuously make their existence worthy of trust and secure an acceptance from a thinking public both lay and professional.

In spite of some tendencies, which will certainly prove temporary, modern medicine continues to advance and to bring one disease after another under the control of physician and of patient who will read the laws of health aright and follow the inferences from proved facts as fast as they may be formulated by a hard-working and scientific profession. The medical profession of to-day subscribes without reserve to the definition of science formulated at the Washington conference in 1923 as: "The developing without prejudice or preconception of any kind, a knowledge of the facts, the laws and the processes of nature"; and applies this precept to the detail of its daily work.

Many of the illustrations in this volume are reproduced from photographs and engravings in the collections of the New York Academy of Medicine, of Drs. William C. Von Glahn and Archibald Malloch. The thanks of the authors are expressed in this place for the privilege of their use.

THE AUTHORS

MEDICAL LEADERS

MEDICAL LEADERS

I

INTRODUCTION

THE cult of medicine is as old as birth, illness and death, and its origins are intimately connected with the beginning of the religions of fear and taboo. Even to-day the priests of many faiths and the medical advisers of the uneducated and ignorant and of the semi-civilized peoples are embodied in one and the same person. The medicine-man of the American Indian and the voodoo priests and priestesses of the African tribes have their counterparts among many peoples now living under primitive and tribal conditions. In fact a recent conviction for lesser degrees of murder in the state of Pennsylvania presents a picture of two men and a boy of fourteen years beating an old man to death in order to free one of them from being "hexed" or bewitched on the plea that the victim was a witch. A similar case was recently reported from a rural community in Hungary, but in that instance the murderer was acquitted. The latest religion to be invented, and that too in the eastern United States, with its semi-deification of an hysterical woman, is a case in point. It is difficult to decide whether the tenets of this sect are more harmful to the souls of its adult devotees or in the medical neglect of the innocent children forced by parental authority to

submit to the treatment of their physical ailments exclusively by an emotional appeal.

There is a historical record of medical usages scattered through the general books of early history and literature, but only a few "books" of an exclusive medical content date back into the fifteen centuries before the time of Hippocrates. Medical points of view dating from two thousand years B.C. are preserved in the Brahman records of India, in those of the followers of Zoroaster, in the cuneiform inscriptions on the monuments of the Assyrians and Chaldeans, and in the papyri of Egypt and the ancient texts of the Hebrews. Among each of these peoples medicine was a cult and existed with its tutelary gods and goddesses and its religious priests. Later when these became lay practitioners the first physicians were recognized as such.

The practice and tradition of medicine were handed down by an exclusive fraternity, whether lay or sacerdotal, among the Indo-Iranians, in the valleys of the Tigris and Euphrates, in Egypt and without doubt as part of the culture of Minoan civilization from which Greece developed. The names of the gods of medicine of the Greeks are of some interest. Apollo was the chief, Æsculapius the lesser deity, and the daughters of Æsculapius, Hygeia and Panacea, were the goddesses. The ancient medicine of the Greeks was not different for many centuries from that out of which it grew. But medicine developed in Greece as all else developed, and as Greece became the center of excellence in art, in literature, in politics, Grecian medicine rose above all previous knowledge, and the books of Hippocrates,

though full of errors from the modern view-point, stand to-day as the first known record of medical experience associated with a scientific and rational system of philosophy and practice.

Man has always been inclined to explain phenomena which he does not understand on the basis of the supernatural. As education and enlightenment have progressed, the rôle of the supernatural in the production of natural phenomena has assumed a decreasing importance. The history of medicine begins with man's conception of disease as a phenomenon brought about by supernatural agencies. The nature of these agencies differed with different races in accordance with their form of religion and folk-lore. Man, while in the early stages of intellectual development, is always priest-ridden, and his medicine is controlled by superstition and taboo. Primitive races regarded disease as a result of the invasion of the body by demons which must be placated or exorcised. To prevent the resulting disease, charms and amulets were worn. This, it might be said, was the earliest form of preventive medicine. When the demons effected entrance into the body various grotesque practices were indulged in to induce these evil spirits to leave. Often the individual was subjected to vigorous rubbing and pommeling—the earliest form of massage—or was subjected to fumigation with unpleasant and offensive vapors. The rationale of such treatment rested on the supposition that the demons would find the application of the treatment even more distasteful than did the sufferer and so depart.

Historically, probably the oldest surgical operation is

that of trephining. This procedure was practiced by prehistoric man with flint instruments. The object for which a hole was made in the skull was to allow the easy egress of the demons of disease from the body. The disks of bone thus removed were perforated so that they could be worn around the neck and were treasured and worn by other individuals to ward off a similar disease.

The developing philosophy of medicine in the years before Hippocrates, even one thousand years before, among the Iranians, the Egyptians and Chaldeans, was founded on the assumption of four fundamental elements: water, earth, fire, air; among the Hindus a fifth essential element, ether, or spirit, was added. Health was the retention of a proper and regulated association of these elements in the living body; disease was a change in such harmonious action; death was the loss of the pneuma or spirit, and the resulting coagulation of the blood. The practice of these physicians has left its mark on the methods of to-day, as is evidenced by the use of emetics and purges in acute diseases, of poultices, enemata and ointments. The internal administration of such modern drugs as niter, sulphate of copper, alum, camomile was common. In Egypt there were physicians who specialized in diseases of the eye, the head, the teeth, as well as in internal diseases.

The physicians of these centuries freed themselves from priestly dominance but inherited a tradition of discipline and procedure that was both rigid and exacting. They were held to a strict accountability for their care of the individual by an oath more ancient than the better-known form attributed to Hippocrates.

The Oath of the Hindu Physician is transcribed thus in *The Peaks of Medical History,* by Charles L. Dana:

> "You must be chaste and abstemious—speak the truth—not eat meat—care for the good of all living beings—devote yourself to the healing of the sick even if your life be lost by your work—do the sick no harm. Not even in thought, seek another's wife or goods. Be simply clothed and drink no intoxicant—speak clearly, gently, truly, properly—consider time and place. Always seek to grow in knowledge. Do not treat women except their men be present—never take a present from a woman without her husband's consent. When the physician enters a house accompanied by a man suitable to introduce him there, he must pay attention to all the rules of behavior in dress, deportment and attitude. Once with his patient, he must in word and thought attend to nothing but his patient's case and what concerns it. What happens in the house must not be mentioned outside. Nor must he speak of possible death to his patient, if such speech is liable to injure him or any one else. In face of gods and man, you can take upon yourself these vows, may all the gods aid you if you abide thereby, otherwise, may all the gods and the sacra, before which we stand, be against you."

The pupil shall consent to this, saying, "So be it."

The discovery at Susa in December, 1902, of a stone inscribed with cuneiform characters carries the known

control of medical practice by law back to 2250 B.C. The text determines the fees for medical services and the penalties for malpractice in many instances of treatment of disease and of surgical operations. Two sample edicts from this Code of Hammurabi will suffice to appreciate the whole: "If a physician open an abscess (in the eye) of a man, with a bronze lancet and destroy the man's eye, they shall cut off his fingers," and again: "If a physician operate on a slave of a freedman for a severe wound with a bronze lancet and cause his death, he shall restore a slave of equal value." Such stones carrying full legal details were undoubtedly set up in public places in many cities of the Babylonian Empire. This one stood in the Acropolis of Susa; it is over seven feet high and was erected during the reign of Hammurabi, sixth king of the first dynasty of Babylon. The physician of these earliest days was controlled by stringent laws administered by government and by moral obligations formulated by his colleagues and sworn to by him on being admitted to the exclusive circle of the profession.

ÆSCULAPIUS

In Greece medicine grew and developed as did politics, literature, and the arts of sculpture and architecture, and the years 700 to 500 B.C. culminated in the production of the Hippocratic collection of medical writing. The medicine of Greece was influenced by the priestly medicine of the East, but it also had its traditional inheritance from the mythology of Greece itself. Orpheus, the physician, healed the sick with medicinal

plants, with music and incantations. The physician, Chiron, who is represented in art and mythology as a centaur, is noted particularly as the teacher of Asklepios, or Æsculapius. The latter was the companion of Jason on his fabled expedition to find the Golden Fleece in the twelfth century B.C. Æsculapius was deified as the tutelary demigod and founder of Grecian medicine. Temples were erected in his honor where for five hundred years (1200-700 B.C.) the priestly brotherhood of the Asclepiads practiced medicine. His name is still associated with the profession, and his staff with the encircling serpent has become one of its traditional insignia. Many marble statues are found in modern museums which represent Æsculapius as a bearded demigod clothed in the robe of a Grecian philosopher. He is usually leaning on a thick staff about which a serpent is coiled. The frontispiece of this volume is reproduced from a statue in the Museum of the Baths at Rome. (Figure 1.)

The Greeks built temples for the worship of this health-giving god, which were called *asclepieia* and located at sites renowned for their scenic beauty, their pleasant climate and the reputed healing powers of the near-by waters. They were architecturally beautiful, and well-constructed with regard to sanitation. Gradually becoming more than temples of worship, they finally assumed all the functions of sanatoria. They were conducted at first by priests who not only carried on the religious rites but also became in fact physicians practicing the art of healing by other methods than purely that of appeal to the divine. To these sanatoria the sick came from all parts of Greece. The walls of the

temple were covered with tablets erected by former patients in gratitude for the cures wrought upon them, the details of which were inscribed on the tablets. Thus patients were inspired with a confidence in obtaining relief which started them auspiciously on a wholesome régime of diet and baths. The temples at Cos and Cnidus became the most celebrated and developed into distinct schools under the physicians of the Hippocratic period. This cult of Æsculapius was handed down, and as late as 375 B.C. such a sanatorium for the healing of the sick by hydrotherapy and gymnastics, and according to the methods of the Hippocratic School, was founded at Epidaurus in Argolis, Greece. The buildings were built in the best period of Grecian architecture and formed a beautiful temple.

The historical sequence of events in medicine, as in any other development of knowledge and of the mind of man, has been slow and gradual; the older views continue and run parallel to those more recently conceived and formulated. The age of priestly medicine did not cease on any particular date and give way to the age of the logical and scientific methods which was dominated by Hippocrates, his contemporaries and their followers. The age of sacerdotal dominance in medical thought is by no means past in the twentieth century so far as certain sects are concerned. Individual priests of many religions still claim the power to heal even organic disease by prayer and talismans of more or less authentic antiquity. It is by no means strange that old temples should exist and new ones be established, devoted to the priestly exercise of the healing art, at the same time that the

Hippocratic collection of medical tracts should have been in active use and expressed in written form. The transition from a priestly to a lay profession of medicine was aided by a group of Greek thinkers and students of human life and death and the illnesses of man and the conditions of their occurrence.

The question of a proper régime of living and of diet which could control the errors interfering with health, was made the subject of deep study by these same men who formulated the beginnings of Grecian philosophy. This group of philosophers was made up largely of Ionians, whose views of the ultimate causes of things were founded on the old prehistoric ideas of the four elements of the earth and its inhabitants. One finds a tendency to simplify these theories on one hand, and to make them more complicated on the other. Anaximander, living in Miletus about 570 B.C., believed that earth was the primal source of life, and his contemporary, Thales, adopted the Buddhist view that the origin of life was water. Anaximenes of Miletus (540 B.C.) placed his faith in air and was followed by Diogenes of Apollonia (460 B.C.), emphasizing the importance of the breath, or pneuma, which was described as distributed throughout the body by the arteries arising from the aorta and heart. This idea was the beginning of the false notion that the arteries contained air, which complicated medical progress for many years. Heraclitus of Ephesus, living in 500 B.C., turned to fire as the chief cause of all, as also had Pythagoras (580-510 B.C.) of Samos before him.

Pythagoras had many followers and admirers, and

presided and taught in the school at Crotona. The philosophy of Pythagoras conceived of man as a diminutive world, a microcosm, a lesser model of the universe or macrocosm. His theory of numbers has influenced mankind by his development of geometry. His formulation of the theory of metempsychosis with its blood-brotherhood of men and animals led to a taboo against the eating of meat and to ascetic rules of living. Dietary rules for eating, working and resting, with incantations, music and magical formularies against disease were included in his medical teaching. Applying his theories of numbers to medicine, Pythagoras gave greater influence to the odd than to the even numbers, and especially to the number seven to which he attributed a control in the crises of disease and marked the seventh, fourteenth and twenty-first days as days of special significance. The theories of medicine did not remain simple during the dominance of the pre-Hippocratic philosophers, and scientific investigations and critical analyses of facts were practiced first by the School at Cos.

Alcmæon at Crotona (500 B.C.), a follower of Pythagoras, is recorded as a dissector of animals, and his theory of health and disease is complicated by assuming an influence in the interrelations of cold and heat, of dryness and moisture, of the sweet and the bitter qualities of the four accepted elements: fire, air, water, earth. The various parts of the body also began to be recognized as influencing the state of mind and body. The organs of generation and the navel as the seat of generation, the heart as the home of the soul,

and the brain as the site of the intelligence, became important factors in medicine. The secretions, and especially the bile, whether black or yellow, the blood and mucus (phlegm) were emphasized as a cause of disease, and a theory of similars was propounded as an active guide in medical practice. And finally, Democritus, a contemporary of Hippocrates, whose writings have been lost, is known as the author of an atomic theory by which all matter is made up of invisible atoms in constant motion surrounded by a vacuum. These theories had an immense influence on medicine.

Coincident with these philosophical physicians and the medicine which they were developing and practicing, a sect of practitioners flourished who laid great stress on exercise and a healthy regimen of living. The palestra, or training schools for children, and the gymnasia for the regulating of exercises and baths for adults, in which the surgical treatment of fractures and dislocations and of ulcerated sores was carried on, became a prominent factor in the life of the Greeks.

Medicine in the fifth century B.C. in Greece had reached a high degree of development. There was a sound and reliable art of medicine taught in the schools which were established in the older temples dedicated to Æsculapius and dominated by masters of known reputation and authority. The followers and pupils of these great personalities traveled about the world and settled for greater or shorter periods in various cities, as did also the more prominent members of the profession. Specialization was recognized as a legitimate division of the practicing physicians, and diseases of the eye, of the

teeth, of the abdomen, the treatment of fractures by specialized bone-setters, the operation for removal of stone from the bladder, for example, were made the specialties of individuals. Sometimes certain families handed down secret methods of procedure from one generation to the next. At the same time sorcerers and sellers of amulets, exorcisers of demons and fakirs from Egypt and the Far East undoubtedly remained in active work among the people. This condition of affairs, in which an art of medicine following scientific methods and based on a study of the natural course and sequence of the symptoms of disease existed side by side with an illogical practice of caring for the sick dependent on an inherited ignorance of nature and supported by a fear of the unknown, has a very modern sound. The twentieth century A.D. has no claim to boast of a broader understanding or a keener judgment on medical matters than had the fifth century B.C., at least as far as many peoples and as many individuals living among the highest civilized nations are concerned.

The modern cults of irregular medicine which are so prevalent in civilized countries make an appeal to the ignorant and to the sufferers from chronic and incurable diseases. These quacks are glib talkers who will promise a cure even in cases of inoperable cancer or will make a false diagnosis of cancer, for example, in some simple disease. When the unfortunate patient dies the result is explained as caused by the patient or his physician: delay in consulting the quack has made the case hopeless, or previous treatment has prevented the cure. When a patient recovers from the "cancer" or other non-existent

disease the credit is taken by these insidious purveyors of cures, some of whom possess degrees in medicine to the discredit of the schools. These fraudulent practitioners grow rich on the hopes and fears of persons who are dying or who have functional nervous symptoms without organic disease of any kind. The modern fads of spinal adjustments, of nature remedies, of water-cures and such like fancies form another group of modern quackeries which has a history as old as the folk-lore of ancient Greece.

II

HIPPOCRATES

The Medicine of Greece

The traditions of medicine, the art of medicine, the science of medicine, the close and intimate relationship existing between individual physicians of whatever nationality are symbolized in the name of Hippocrates. The ideals and the rules of ethics of the profession are concentrated in the short code which is included in the written words attributed to Hippocrates and known as the Hippocratic Oath. This historical background dates from the fifth century B.C. A very few members of the profession to-day ever look for a beginning of the history of medicine prior to the century of Hippocrates of Cos. And yet coincident with the school at Cos there existed in the Greek world a rival school at Cnidus on the Asiatic coast of the Ægean Sea, where Chrysippus was the guiding authority, and also other schools of which the names alone have come down to us: at Crotona in Italy, on the island of Rhodes, at Cyrene in Africa and at Athens.

Hippocrates

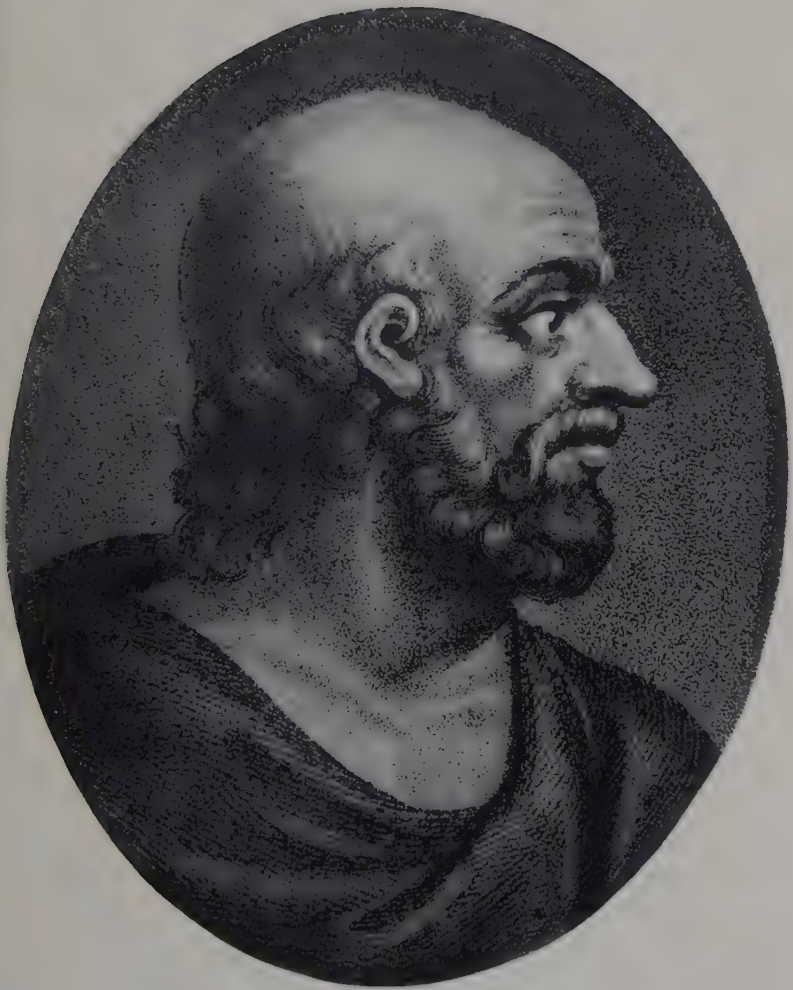
Hippocrates was the contemporary of Phidias, the sculptor; of the writers of tragedies, Sophocles and Euripides; of Aristophanes, the author of

comedies; of the philosophers, Socrates and Plato, and the historians, Herodotus and Thucydides. Hippocrates was called the Great Physician by Aristotle who lived a century after him. He was born on the island of Cos, 460 B.C., and died at Larissa in 370 B.C. in his ninetieth year. He was the son of Heraclides, the Asclepiad, and thus came of a family of physicians. It is not known whether he was originally one of the priest-physicians practicing at the Asclepieion at Cos or whether he practiced independently in the adjacent city. He spent the greater part of his life at Cos but for a period traveled in foreign countries observing medical methods. His travels included Athens, the cities of Thessaly and the Black Sea, and of Asia Minor and Egypt. He was survived by two sons, Thessalus and Draco, of whom but little is known, and by a son-in-law, Polybius, who was one of the most celebrated physicians of the time, and who wrote at least one of the Hippocratic books describing the veins.

It is not strange that there should be a legendary Hippocrates and that fables should have grown up in Greece itself about so celebrated a man during several decades after his death. Such a legend is the story of the fires lighted by his orders in Athens during the plague. It is pure fiction that he refused presents from the Persian emperor, Artaxerxes. There was current an anecdote that Hippocrates was requested to examine the mental condition of Democritus, the philosopher, and pass upon his sanity. Democritus was found studying natural philosophy and when asked by the Great Physician what he was doing, replied that he was contemplating the fool-

ishness of men. As a result of the interview, Hippocrates expressed the opinion that Democritus was the wisest of men. The tomb of Hippocrates was visited as a shrine of health up to the second century A.D. when it is reported that it contained a hive of bees whose honey was thought much of as a sovereign remedy against the sore mouth of nursing infants.

Biographical facts concerning Hippocrates are few, but his personality can be easily judged from his writings. These reflect a kindly man of great intellectual power, of calm and judicial temperament, accurate and careful in observation, possessed of a high sense of the dignity and lofty ideals of his profession. He was held in great respect by his contemporaries and especially by Plato. No portrait bust or ancient marble can possibly be identified as a representation of the Father of Medicine. Many of the heads labeled with his name may easily be ascribed to an intended portraiture of the idealized Æsculapius. The picture of Hippocrates given in this book is copied from an engraving by J. Chapman, dated 1809, which in turn was taken from an ancient intaglio. It gives an idea of a keen thoughtful man somewhat bald and bearded like his contemporary philosophers of perhaps sixty years of age. (Figure 2.) Hippocrates is a tradition in medicine but a tradition which is founded on a very substantial basis—on a book. He is not a myth but was a real personality, and the book known as the *Works of Hippocrates* is the earliest book on medicine which has been preserved from the Greek schools; it is many centuries later than the known papyri of Egypt in which the state of medicine of the tenth century B.C. and earlier is recorded.



From an engraving by J. Chapman of ancient Gem, property of I. Tassie, published by I. Wilkes, October 24, 1809, in the Collection of William C. Von Glahn, M.D.

Figure II

HIPPOCRATES

To modern minds and to the history of medicine, Hippocrates is a Book. This volume is made up of some sixty chapters or "books" and has been inherited by the profession as a result of an editing and compilation in the environment of the School of Alexandria. Various modern commentators have analyzed the sources of these sixty-odd books, and it is recognized that no more than twelve (Littré) can be attributed to Hippocrates himself. Daremberg, a still later critic, gives the Father of Medicine credit for only two.

It matters little how many authors are represented, the whole series presents a resumé of the medical knowledge of the time of Hippocrates. The picture is one of scientific analysis, of careful observation and of logical conclusions which may well serve as a model to many writers of to-day on the same subjects. This is true although the theories of the causation of disease are false and the resulting treatment often incorrect. The manner of writing and the spirit which inspired the books are modern and wholly deserving of praise. The oldest known manuscript is in Florence, dates from the ninth century and is called *Codex Laurentianus*. Other good manuscripts of the tenth and eleventh centuries exist in Paris, Vienna and Venice. After the invention of printing by Gutenberg in 1455, the book was first printed in 1525 by Calvus at Rome in a poor Latin translation. The Greek text was published by Aldus and Asulanus in Venice in 1526, and at Basel by Conarus in 1538, and the best Latin translation of Anutius Foësius was published at Frankfort in 1595. The monumental translation and study of Littré was published in the French language in ten volumes (1839-1861) and, with the translation by

Fuchs published in 1895-1908 in three volumes, still forms the last word on this fundamental presentation of the Art of Medicine. A complete translation in English will be completed shortly in the Loeb Classical Library.

Hippocrates inherited from his teachers the facts and fancies, the theories and practices which had come down from the preceding fifteen hundred years of tradition and legend in the practice of medicine. The short resumé given above attempts to show from the facts known about his predecessors just what were the sources and the state of medical knowledge prior to the time of the great Father of Medicine. This portrayal is inadequate and lacking in many details, for written testimony does not exist. It is certain that much if not most of the contents of the writings of Hippocrates is a compilation of accumulated knowledge and not new material discovered either by himself or by his students and contemporaries of other schools.

Hippocrates combated the idea that disease was a manifestation of supernatural influence. As to the nature of the true causes of disease he constructed an explanation founded on what is known as humoral pathology. He believed that the four elements—heat, cold, dryness and moisture—were represented in the body by four body fluids—blood, phlegm, black bile and yellow bile. In conditions of health these fluids existed in the body in harmonious proportions. When these proportions were disturbed, or unbalanced, disease resulted. From the standpoint of permutations and combinations it can be seen what a number of diseases might result from disturbances in the balance of these four fluids. This theory

was supported strongly by Galen four hundred years later, and remained the accepted doctrine as to the causation of disease for centuries. The followers of Hippocrates constructed ingenious methods of treatment to cure disease based on this theory of its causation. In the use of drugs they attempted to exhibit such ones as possessed the opposite quality to that which predominated in the disease. For example, in a condition in which phlegm or cold predominated, a drug which possessed the opposite quality of heat was administered.

Hippocrates could not see much in this because he confessed he could not tell which drugs possessed such qualities and felt that other physicians resorted to their imaginations in selecting such drugs. In his own method of treatment he relied upon nature, which he considered the great healer, and he believed in following the policy that would assist nature. This he did by measures founded on common sense, consisting in supervision of the patient's surroundings as to light, air and cleanliness, by encouragement and by advice as to diet and exercise. He advised moderation in all things—working, eating, drinking, exercising, sleeping—as a preventive of disease. He used emetics, purges and enemata, phlebotomy, drugs which have been discarded and others which have a known value to-day—asafetida, myrrh, alum, niter and dried ox-gall, and probably opium which was known in his day although it is not mentioned in the Hippocratic books. Warm baths and applications of cold water, inunction of aromatic oils, local application of cups and blisters and the cautery were employed. He taught that many diseases may be cured spontaneously, that the

physician must strive to imitate nature and do no harm in directing the course of a disease to recovery, and that diseases which never get well spontaneously can never be cured by the art of the physician.

Hippocrates was one of the first to point out that different diseases were to be distinguished by characteristic groupings of symptoms. Greek physicians before this time described cases of illness by the recital of a long list of symptoms. Each and every symptom was set down without emphasis or attempt at correlation. Some symptoms were common to many diseases. Fever and its concomitant symptoms,—headache, thirst, dry skin,—for example, may be present in diseases of the respiratory tract or may be present in diseases of the gastro-intestinal tract. In diseases of the former, the fever is apt to be accompanied by cough or pain in the chest; in diseases of the latter, the fever is apt to be accompanied by abdominal discomfort, nausea or diarrhea. Hippocrates laid stress on individual symptoms; he separated the essential from the unessential ones; he pointed out that the combination of certain symptoms formed a clinical picture which characterized a specific disease and differentiated one disease from another.

His writings contain classical descriptions of gout, arthritis, puerperal septicæmia, tuberculosis, mumps, hysteria, epilepsy, and different types of malaria which are still designated by the Hippocratic nomenclature as quotidian, tertian and quartan. These descriptions with a few changes would be appropriate for a modern text-book. Hippocrates describes acute inflammation of the throat, peripneumonia, tetanus, erysipelas, inflamma-

tory diseases of many organs, and also paralysis due to cerebral apoplexy, as well as the diseases of the spinal cord now known as transverse myelitis, and infantile paralysis. Perhaps the most remarkable book from the modern view-point gives his description of pleurisy and the operation for purulent inflammation of the pleura. For this condition he advises the opening of the chest between the ribs, and he makes his diagnosis by the location of the pain and the presence of a splashing sound in the chest. This evidence of air and fluid in the chest is a very unusual physical sign of disease to-day because the modern methods of physical examination of the patient permit of an earlier diagnosis than was available to the physician of the fifth century B.C. That Hippocrates mentions it at all, means that the pleurisy of his book includes not only empyema or purulent pleurisy, but also the perforation of the lung in tuberculosis and in abscess. Hippocrates also describes the sounds heard when adhesions exist and cause friction between the lung and the chest wall. How much more he knew of the physical examination of the chest can only be surmised, but he could hardly have heard these frictions without putting his ear in direct contact with the chest, and he does recommend that the physician use his powers of observation, of touch, of hearing, of smell and of taste.

The Hippocratic writings pay comparatively little attention to diagnosis but lay great stress on prognosis and the possibility of cure or of the death of the patient. Emphasis is laid on variations in the appearance of the eyes, the color of the skin, the prominence of the veins,

pulsations in the arteries, the existence of fever, chills, tremors, sweating, frequency of respiration, the position of the patient in bed, the condition of the tongue, and the influence of environment on health and disease. One speaks to-day of the Hippocratic facies as evidence of a patient exhausted by an acute febrile disease which is noted by the Hippocratic authors as "deep-set eyes, contracted nose, cold ears with prominent lobes, forehead dry, face livid or yellow or leaden." The medical terms used in the books of the fifth century B.C. have persisted to the present time. The word *crasia,* meaning the healthy relationship of the humors of the body, is found in the modern *dyscrasia,* meaning an abnormal tendency of the human individual. The return to health is brought about by a *coction* (a "cooking") of the humors disarranged by disease, which is indicated by the sudden cessation of symptoms of fever with the increases in the excretions, and which is still known as a "crisis."

The Greeks were observers rather than experimenters. This was true of Hippocrates. Dissection of the human body was barred by the prejudice of religion and custom. What anatomical knowledge there was, was gained by animal dissection. It is probable that Hippocrates possessed only a superficial knowledge of the position and structure of the internal organs and even less idea of the physiology or function of these organs. The Hippocratic books taught that the veins arise in the liver and carry blood to and fro, the arteries originate in the heart and conduct the spirit and the breath, and both veins and arteries supply heat, moisture and air to the other parts of the body.

In the field of surgery Hippocrates' best contributions are contained in the theses on fractures and dislocations. His description of the dislocation of the shoulder and the treatment for it will bear comparison with that of almost any writer since his time. While he possessed no knowledge of asepsis in its present meaning, he was emphatic in his directions as to cleanliness. The surgeon is enjoined thoroughly to cleanse his hands and nails before touching a wound and to wash the wound only in water of known purity or in water that had been boiled.

The practice of medicine in Greece was not limited to the temples of Æsculapius. These sanatoria were visited for medical care by the poorer classes in large part, though probably the better educated and well-to-do also patronized them as temples of health in so far as a religious feeling was an incentive to overcome disease. The Greek physician had also his professional home or *iatreion* where he could care especially for surgical diseases and fractures, and other injuries the result of accidents. These *iatreia* are described in the *Works of Hippocrates,* and explicit directions and rules are given to insure cleanliness and surgical comfort in the treatment of such cases. The *iatreia* were not hospitals in the modern sense but resembled in organization and work the modern dispensary.

In these books of the Hippocratic collection there is mention of the characteristics necessary for a physician and of the deportment which should govern his life. The physician should have good health; he should be sympathetic but firm in his relations with his patients; he

should be personally clean and dressed in correct attire; he should never seek notoriety in act or word; he should be temperate in eating and drinking; he should be always ready to combat disease and explain the doubts and allay the fears of his patients and their friends and family. He should never tell a patient, however ill, that he is in danger of dying, and should be ready to call in the most skilled physician in consultation over difficult and serious cases. He should not be too eager for remuneration but he should despise money, calumnies spoken by others of himself, and of quacks; in brief, the physician should be philosophical and against every temptation, an honest man. In the book known as *The Law* certain aphorisms are written which will apply to the study of science and especially to medicine for all time. The best known of these is usually quoted only in part and is an inheritance treasured by all the world: "Life is short and Art is long; the Occasion fleeting, Experience fallacious and Judgment difficult."

Hippocrates gathered about him at Cos large numbers of students, instructing them in the art of medicine and inculcating in them the highest conceptions of the dignity of the profession. Upon his teachings were founded the rules of conduct for physicians known as medical ethics. The medical student to-day, upon graduation, subscribes to a modification of the Hippocratic Oath, which, if not original with Hippocrates, embodies the ideals for which he stood. The oath as administered to Greek students of his time is not applicable to modern conditions. The modern citizen does not take oath by swearing "by Apollo the physician and

Æsculapius and Hygeia and Panacea and all the gods and goddesses." The modern physician does not abstain from performing operations for stone of the kidney and bladder, as required of the Greeks in the fifth century B.C. The late Professor John G. Curtis, of the College of Physicians and Surgeons, formulated the Hippocratic Oath on modern lines, and his translation, which is really a paraphrase of the Greek, is publicly administered at each commencement to the candidates for the degree of Doctor of Medicine both at Columbia and at Cornell Universities. It is as follows:

"I do solemnly swear by that which I hold most sacred:

"That I will be loyal to the profession of medicine and just and generous to its members;

"That I will lead my life and practise my art in uprightness and honor;

"That into whatsoever house I shall enter, it shall be for the good of the sick to the utmost of my power, I holding myself aloof from wrong, from corruption, from the tempting of others to vice;

"That I will exercise my art solely for the cure of my patients, and will give no drug, perform no operation for a criminal purpose, even if solicited, far less suggest it;

"That whatsoever I shall see or hear of the lives of men which is not fitting to be spoken, I will keep inviolably secret.

"These things I do promise and in proportion as I am faithful to this my oath may happiness and good repute be ever mine—the opposite if I shall be forsworn."

Plato and Aristotle

The era of Hippocrates was made especially famous by the work of two men who are known as philosophers rather than as physicians. The first, Plato, who was born in 430 B.C. and died in 347 B.C., was therefore thirty years the junior of Hippocrates; Aristotle, the second remarkable mind of this period, was born in 384 B.C., fourteen years prior to the death of the great physician of Cos. He died in 322 B.C. at Chalcis in Eubœa, having been expelled from Athens for political reasons by the anti-Macedonian party of Demosthenes. Plato's philosophy is a theoretical presentation of the nature of life, of the political organization and customs of the State (the Republic) and of the characteristics of the human body, both physical and mental, especially mental. His idealistic philosophy has had a lasting influence on medical theories, but Plato's work in medicine has no interest for the clinical student of diseases and their treatment. Plato formulated the idea of a human soul which was spiritual and immortal and entirely separate from the physical and mortal body. His teaching led to the conception of vital and animal spirits which died with the body, and Plato himself speaks of an intellectual spirit or soul residing in the brain and ruling over human intelligence and the organs of the special senses: the eyes, ears, nose and tongue; also a soul of the emotions of anger and courage residing in the heart, and lastly, a vegetative soul presiding over digestion and nourishment from its seat in the liver. He added nothing to the humoral theories of Hippocrates and believed

that chronic invalids and incompetents were a burden to the State and that physicians should not cure them; nevertheless he held the profession in high esteem and mentioned Hippocrates with unstinted praise.

Plato's idealism would bring him to-day in conflict with the valetudinarian uplifters and hygienists who by modern methods of preventive medicine are overpopulating civilized countries with weaklings and those unfit to withstand the slings and arrows of this naughty world. Vertebrates this new race may be, but mammals many of them certainly are not, for though they propagate their kind, their young are, like MacDuff, untimely ripped from their mothers' wombs by Cæsarean section. Nourished by artificial foods and vitamines, only a comparative few of this weakened progeny die of kindly epidemics that a greater proportion of the fittest may survive and produce a healthier and more efficient race in future generations. The best copy of the manuscript of Plato's *Republic* is the *Codex Clarkianus* of the Bodleian Library. A Latin translation by Ficino was printed in 1482 and the Greek text by Aldus and Musurus at Venice in 1513. Benjamin Jowett's translation in English was published in five volumes at Oxford in 1871.

Aristotle was born at Stagira in Thrace; he was the son of Nicomachus, the physician of King Amyntas of Macedonia. He inherited the traditions of a physician from three generations and was trained in his youth as a member of the profession. When seventeen, he became a pupil of Plato, with whom he remained in the closest friendship in spite of marked differences of opinion in regard to their philosophical ideas. When forty-one,

he was recalled to Macedonia to become the teacher of Alexander, the son of King Philip, remaining there eight years; he then returned to Athens and founded the Peripatetic School. Aristotle left no branch of learning unexplored, and he extended human knowledge in many directions, more particularly in his investigations of the lower animals. Through his connection with the great conqueror, Alexander, he was able to collect the bodies of many kinds of beasts hitherto not put to scientific investigation and dissection. It is equally certain that he never examined the bodies of dead human beings. He founded the science of comparative anatomy and left a mark on human thought that has endured to this day.

In purely medical theories he was a member of the School of Cos, but added a fifth element, the spiritual, to the accepted fire, air, earth and water. He set fire above the other three as not being liable to putridity (sepsis). Digestion was the result of coction by heat, which was the cause also of pus, of tears and of mucus. He adopted from Plato the idea that everything, every organ in the body, had an ultimate purpose and predetermined reason for its existence. The heart was described as of three and not four cavities, and as the most important organ of the body and one which could never be seriously diseased—an idea which hampered medical progress for centuries. The lungs served only to cool the heart. Although the pulse was located in the arteries, these were supposed to contain air, and the veins, blood. Nourishment by the vessels was compared to the absorption by plants through their roots. His

analysis of fevers was the same as that of Hippocrates, and he paid much attention to environment, to the seasons and to variation in the weather as causes of disease. He recognized contagion in cases of phthisis, of the plague, of the itch and of ophthalmia, and attributed the cause in each case to a morbific something in the air.

Aristotle was an investigator and a greater naturalist than a physician; as a philosopher he was a realist, as opposed to his teacher, Plato, the idealist. The best manuscript of Aristotle's most important work in science dates from the thirteenth century. It is transcribed by Albertus Magnus and is stored in the library at Cologne. The first printed edition of his complete works is from the press of Aldus, in five volumes, and is dated at Venice in 1495-1498. The *De Animalibus* was printed in 1476 also in Venice by Koln and Manthen. A fine translation in English was published in six volumes at the Clarendon Press, Oxford, in 1908-1912.

Theophrastus

Theophrastus, of Eresus in the island of Lesbos, 372-287 B.C., was the immediate follower of Aristotle as the teacher at the Lyceum. He pursued the scientific leads of his master rather than the spiritual teachings of Plato. He accomplished for the vegetable world what Aristotle had done for animals. His work on botany, consisting of nine books on the history of plants, has a distinct bearing upon the practice of medicine. This

book has been preserved in a manuscript known as the *Codex Urbinas* which is now in the library at the Vatican. It was printed in Greek text by Aldus in Venice in 1495 and 1498, and a Latin translation by Theodore Gaza was printed by Confalonerius at Treviso in 1483. An English translation by Hort was printed in the Loeb Library in 1916.

Herophilus and Erasistratus

The Macedonian Greeks under Philip and Alexander conquered the Eastern World as far as the Indus. The latter established a new city called Alexandria, at the mouth of the Nile, which became the center of Greek culture. Rome had not yet been heard of as a world power but was busy establishing her rule over Italy and was shortly to contest the supremacy of the Mediterranean with Carthage. The Macedonian Empire fell apart, and its discordant elements were divided between the generals of Alexander when that conqueror died in 323 B.C. (It is a notable coincidence that Aristotle and Alexander, the leaders of Grecian thought and of Grecian political power, both died within the same twelve months.) In this division, Egypt fell to Ptolemy Soter who ruled as king from 323 to 285 B.C. This ruler took a great interest in Greek culture and made Alexandria a center of art, literature, the drama and philosophy. He founded a so-called museum with a library in which the writings of all known authors were collected, and teachings and investigations were fostered as never before. A second library was started later in

a temple of Serapis, the Serapeum, and Alexandria became the seat of an institution for the advancement of learning under royal patronage and free from priestly influences which was the first attempt to forestall the modern university. The glory of Grecian medicine left its ancient sites at Cos, Athens and Cnidus, and migrated to the new intellectual center in Egypt. Ptolemy furnished every facility to the physicians to study the nature of disease and the structure of the human body.

It was under this environment that the writings of the older physicians of Cos and Cnidus were collected and brought into one large treatise known as the *Works of Hippocrates*. Medicine was still represented by a united profession, and the science of medicine was a logical philosophy even if it was founded on incomplete and erroneous premises. Alexandria therefore was only a further development of the schools of Grecian medicine. Under this liberal treatment, two physicians migrated to the new "school" and made themselves and their institution famous. We know nothing of either of them from their personal writings, for the books both of Herophilus and of Erasistratus are lost and had already disappeared in the time of Galen, four hundred years later. The date is unknown when Herophilus, the elder of the two, was born at Chalcedon on the Propontis in Asia Minor; he was a pupil of Praxagoras who followed Hippocrates at Cos. Erasistratus, who was born at Julis in the island of Chios, about 300 B.C., was the pupil of Metrodorus, the son-in-law of Aristotle. Both are said to have been pupils of Chrysippus at Cnidus, and both therefore came under the influence of the

Schools of Cos and of Cnidus, always looked upon as rival systems of medicine.

Within the limits of the knowledge of his time, Hippocrates and his School were clever diagnosticians. They were astute in the diagnosis and shrewd and careful in the observation of disease, but their knowledge of anatomy and physiology was weak. They refrained from dissection, the only possible way of gaining accurate anatomical knowledge, both because of their temperamental disinclination toward such work and because Greek custom prevented opportunity for doing it. After the founding of Alexandria the Egyptian rulers showed great interest in medicine and did everything in their power to collect medical writings of foreign sources in their libraries. They not only saw to it that Herophilus and Erasistratus were supplied with bodies for dissection, but it is said that they also supplied the bodies of living criminals for vivisection. This was done in order that the motion, color and function of the organs might be studied in the living state. How much of such vivisection was done is not known. It naturally aroused a storm of just protest and criticism, and it is doubtful whether the victims survived the opening of their body cavities long enough to permit of any study worth while.

Herophilus, as the result of his researches, was a prolific contributor to anatomical knowledge. As a result of his studies of the nervous system he gave the first description of the large blood-vessels or venous sinuses contained in the coverings of the brain, and their meeting-place at the base of the skull cavity bears his name—the torcular Herophili. He was the first to point out

that there were two types of nerves: one type carrying sensory impulses toward the brain, the other carrying motor impulses from the brain to the muscles. He also described some of the parts of the brain itself, especially one of its cavities,—the fourth ventricle. Dissecting the human eye, he described the retinal coat of the eyeball, the lens, and the fluid in the chamber of the eye behind the lens. He gave names to a small bone in the neck, the hyoid bone; the first portion of the small intestine, the duodenum; and the gland surrounding the outlet of the male bladder, the prostate. In addition to his anatomical work, Herophilus was a celebrated and respected clinician. He gave great attention to the pulse, emphasizing the differences which occurred in rate, regularity, force and amplitude.

The contributions of Erasistratus to anatomical knowledge were concerned particularly with descriptions of the upper chambers of the heart or auricles, the heart valves and some of the heart muscles attaching to its valves. Yet, while he was one of the first to give accurate descriptions of the structure of the heart, he insisted that the heart contained no blood. He was led into this error no doubt by his endeavor to correlate the movements of the heart and of the chest. Apparently realizing the importance of these two bodily functions, he believed that in some way they must be related. He knew that air was drawn into the lungs and was not satisfied with the prevailing explanation that the function of the inspired air was to cool the blood—refrigeration, but believed that the air must be used by the body tissues. Therefore, he contended, air was drawn into the heart

from the lungs and then pumped all over the body through the large vessel leaving the heart. He also contended that the arteries contained only air, the veins only blood, and that the arteries bled when cut because under such circumstances and in conditions of inflammation blood escaped from the veins to the arteries. This is, of course, contrary to all fact, but in a sense the theory of the value and usefulness of the inspired air is an anticipation of the later discovery of the interchange of oxygen and carbon dioxide which occurs in the lungs by osmosis between the blood and the contained air, and the transfer of oxygen from the lungs to the remote tissues by means of the circulating blood.

In addition to his investigations of the heart, Erasistratus did pioneer work on the physiology of digestion. He showed that food on entering the stomach, instead of being digested by a process of heating, was broken up into small particles by contraction and relaxation of the stomach. After this he fell into error by stating that the food entered directly into the liver where it was transformed either into bile or blood. Here again he seemed to sense a physiological truth which, because of the limitations of the knowledge of his time, he could not prove. Centuries later physiologists did prove that the food elements were carried to the liver and built up into blood and bile, but not by the direct route which Erasistratus described.

Erasistratus was well known as a clinician as well as an anatomist. In attempting to explain the reason for the presence of fever in illness he contended that it resulted from the escape of blood from the veins into large arter-

ies which in health contained only air. In order to effect cures with drugs he did not depend upon the administration of the drugs by mouth but cut into the abdomen and applied them directly to the liver and spleen. He was opposed to the treatment of his colleagues and predecessors by bleeding and purgation, and claimed that both were debilitating and had no selective action on the humors of the body.

Alexandria saw not only the height of development of Grecian medicine which was founded on a true scientific spirit of observation and study of the nature of health and disease, but was as well the site of the decline and decadence of this Hippocratic School. The brilliant physicians, Herophilus and Erasistratus, were associated in the Alexandrian museum with the equally fertile minds of Euclid, the mathematician, of Archimedes, the physicist, and of Eratosthenes, the astronomer. The spirit of philosophy was the prevalent type of intellectual thought. The scientific medicine of the fifth to the second centuries B.C. was built on a true clinical experience with disease, and in the Alexandrian School, on a practical investigation of human anatomy and on the vivisection of animals. It failed to discover the fundamental truth of the circulating blood possibly because the animals examined died too quickly to permit of a thorough examination. It failed to understand the nature of disease because the inherited theories of the humors of the body were too deeply implanted in the mind of man to be easily set aside. These ideas had the authority behind them of the great thinkers of the past, especially of Hippocrates and Aristotle. Grecian medi-

cine passed into a temporary oblivion because, lacking a fundamental basis of truth, it could not overcome the influence of the philosophers on the medical workers themselves. The intellectual world of Greece was lorded over by the philosophical speculations of Plato, the idealist, and Aristotle, the realist, and in the time of the preeminence of the Alexandrian School by the equanimity of Epicurus, the apathy of Zeno, the Stoic, or the materialistic cynicism of Diogenes.

III

GALEN

The Final Form of Medicine in the Roman Empire

The Greek physician was a restless soul, and even the leaders in medicine wandered over the earth from city to city. It can not be denied that the mass of physicians in their contact with the common people had to contend with the taboos of religion and the traditions of folk-lore. These physicians must have seen many patients die and have had to explain these unfortunate results to a family unsympathetic to the medical profession. The teachings of the schools must have failed them often and the general profession must have been receptive at all times of new ideas, new theories and new treatments. The tendency of the Greek mind to theorize and to adopt modes of action on *a priori* reasoning made a fertile ground for the development of new modes of medical thought. The conclusions respecting cause and effect were often arrived at by an argument based entirely on the sequence of events; *post hoc, ergo propter hoc.* This manner of thinking is still a handicap in selecting medicines and acts as an incubus in modern therapeutics. The Alexandrian teachings divided into three such schools of thought, and the very human qualities of jealousy, ambition, greed and the love of luxury were introduced into the profession to hamper progress and tend to destroy

the high ideals inherited from Hippocrates and his contemporaries. Perhaps if we knew more of the details of life in the *asclepieia* of Cos and Cnidus in the fifth century B.C. these human emotions of the second century would prove to have been no new thing when medicine was practiced under the deontological tenets of Hippocrates himself.

It was easier to theorize than to investigate, and between the second century B.C. and the second century A.D. medicine was divided into a number of sects, each one founded on some older authority or on the newer ideas of some younger man more ambitious than his colleagues. Those who pretended to follow in the footsteps of Hippocrates, though often with indifferent sincerity, were known as Dogmatists. They found their inspiration in the books rather than in the spirit of that logical and scientific school. The second group were the alleged followers of Herophilus who wandered into sophistries rather than follow the study of anatomy and the teaching of the School of Cos and of their patron. The third group were followers of Erasistratus who combated vivisection as dangerous but who neglected anatomical study as much as their patron had praised it. Both of these latter sects were composed of men trading on a past celebrity and differing but little from the general group of their contemporaries. The sect of Empirics also came out of Alexandria and formed a cult based on practical experience. They discarded the study of anatomy and all inquiry into the causes of disease as of no useful purpose. They laid stress on the means of curing disease which were to be obtained from the physician's own ex-

perience or that of his colleagues. The elements on which experience was founded were the drug, the organ diseased and the nature of the illness. These three formed the tripod of the foundations of Empiricism. Heraclides of Tarentum, of this sect, wrote the first compendium of drugs in which he described some six hundred remedies used by himself. He laid down special directions for the proper employment of sulphur and opium and laid stress on the preparation and proving of drugs. His followers rejected all studies except therapeutics and the search for specifics.

With the beginning of the Empire and the establishing of the Pax Romana, Rome became the metropolis of medicine as of every other form of learning. Greek medicine was brought thither by itinerant Greek physicians who at first were not received with favor. One of these was at first hailed as *vulnerarius,* the "healer of wounds," who later, as the results of his cautery and his knife became known, was condemned as *carnifex,* the "executioner." Cato in particular, an old-fashioned Roman Republican, has recorded his opinion of the introduction of Greek medicine into Rome in a letter to his son which as translated by Daremberg reads: "The Greeks are a perverse and unteachable race. Believe that an oracle is speaking to you when I say, Every time that the Greeks bring to us some branch of knowledge they will not fail to corrupt our manners, and it will be far worse for us if they should send us their physicians for they have bound themselves by an oath to kill all Barbarians by the aid of medicine, and they have the insolence to reckon us as Barbarians. Remember that I have forbidden you to

call in a physician." Later Greek physicians were held in high esteem by the Romans, and in 59 B.C., when Julius Cæsar was consul, foreign physicians were given recognition as residents of the city, and the bar to their settling there was entirely lifted.

Asclepiades

The first physician resident at Rome to exert an influence on medicine was Asclepiades who was born at Prusa in Bithynia in 124 B.C. His education was acquired at Alexandria under Cleophanthus, and he practiced in the island of Paros and at Athens, and finally at Rome. At Rome he taught eloquence and had Celsus and Cicero as pupils. He arrived a poor man, but determined to make his way and this he did by preaching a new "pathy" in medicine which he advanced by his influence over his illustrious patients; as many have done since his day, he made himself famous by talking to the laity rather than to the profession. His personality and pleasing bedside manner soon made him the physician and friend of senators and their families. His colleagues and contemporary physicians did not admire him as much as did his patients and accused him of being something of a charlatan, of contradicting himself in his written book, of prescribing without logic, without method and according to the wishes of his patients. Pliny, the Elder, characterized him "as an Asiatic without resources, having the sole ambition to grow rich, who prescribed laws of health for the human race which many physicians have discarded after his death." Nevertheless such a man was certain

to have a great vogue, and Asclepiades founded a new sect of medicine in Rome. Asclepiades refused to accept the Hippocratic idea of the causation of disease based on humoral pathology. He revived the theory of Democritus concerning atoms in perpetual motion in a vacuum, and believed the body to be a system of pores and solid particles or atoms in free movement, referring especially to the active circulation of the atoms in the intestine as keeping the body in a state of health. According to this theory disease resulted from the clogging of these pores and from a stagnation of the atoms, and he attempted to formulate active measures of relief aiming at relaxation of the pores by heat and baths to cure illness. He denied the existence of critical days and stated that nature was not always benign, but that it often worked in opposition to the cure of disease. He criticized the attitude of the Dogmatists, or Hippocratic School, of observing and assisting nature, which he called a "Meditation upon Death." None the less Asclepiades employed the methods founded on the common sense of Hippocrates regarding a patient's environment and diet, but he presented them from a different view-point. Laying stress on exercise, he originated the idea of the swinging bed that his patient might be influenced by the exercises necessary to overcome stagnation of the atoms causing his disease. He starved fevers during the first three days of the attack, forbidding even water, and introduced, as had his teacher, Cleophanthus, the use of wine in the treatment of fevers. This was as rank a heresy then as it has become to-day in some of the states of the American Republic. The prohibitionists of the ancient

world however usually excluded the treatment of the sick from their taboo.

The Methodists, Pneumatists and Eclectics

Asclepiades' theory of solidism regarding pathology was elaborated by his followers, Themison of Laodicea (123-43 B.C.), who founded, and Thessalus of Tralles in Lydia (51 A.D.), who developed, the sect of Methodism. The Methodists considered disease a simple matter of constriction *(status strictus)* and relaxation *(status laxus)*. Constriction was manifested by a diminution of the secretions and relaxation by an increase. Relaxation might be present in one part of the body and constriction in another and all cases not easily classified were considered to be in a mixed state *(status mixtus)*. This system recommended itself because such a system of medicine could be learned in a short time, and the treatment of disease was simplified into the administration of either one of the two types of remedy,—astringents or laxatives. Among the astringent remedies used were cold baths, cold compresses, living in the cold air, wine, vinegar and alum. The relaxing remedies comprised cupping, blood-letting, leeches, emetics, laxatives, and baths in warm water and oil. Themison formulated his method of therapeutics by the exhibition of drugs and hygienic procedures producing conditions the opposite of the pathology theoretically inferred as existent with the phrase *Contraria contrariis curantur*.

So far as posterity and the history of medicine are concerned a physician who lived in Greece or Rome is known

to-day largely because of his having written a book. Any physician who rose to prominence in Rome did so, however, not so much because of his writings as because of his personality; that he represented any particular school of medicine was of little importance, for none of these could assert its own superiority over the others. There was no fundamental truth in any one of them and one theory of medicine was as good as any other to the lay mind. The sect of Methodism in Rome was no exception, and at least two later physicians who made contemporary reputations, and who have left literary evidence of their careers, are to be numbered among the Methodists. One of these, Soranus of Ephesus, specially known as an obstetrician, wrote in Greek, and the original of his books is lost, but he lives in the Latin translation by Caelius Aurelianus, the second of the celebrated Methodists. In this book of combined authorship the distinction is made between acute disease which is cured spontaneously either by chance or by nature, and chronic disease which requires the attention of a skilled physician. Among chronic diseases these authors include gout, phthisis, elephantiasis, leprosy and migraine, all of which are well described. The first orderly description of a disease with its history, definition, etiology, pathology, symptoms, treatment, diagnosis and differential diagnosis is found in the book of Caelius Aurelianus. Two manuscripts of the works of Caelius Aurelianus existed until 1529 in the Cathedral at Lorch near Worms but have disappeared. One, *Tardarum Passionum,* was printed at Basel in 1529 by Henrie Petri, and the other, *Acutarum Passionum,* at Paris in 1533 by Simonem Colinaeum.

Most of the books written in this period of medical history have been lost. The work of Dioscorides of Anazarba (56 A.D.) on medical botany has survived and shows a careful study and classification of plants. His work includes medical drugs taken from mineral and animal sources as well as from the vegetable world. It is possible to recognize modern plants by his description. Dioscorides had considerable influence upon the pharmacopœia of Galen and his followers. The work exists in a manuscript of the ninth century in the library at Paris, and another known as the *Juliana Anicia* manuscript dates from the sixth century and is owned by the Library of St. Mark's in Venice. It was first printed in a Latin translation by Johan Allemanum de Medemblick at Colle in 1478, and in Greek by Aldus Manutius in 1499.

A sixth sect of medical thought represented at Rome in the first centuries A.D. was known as the Pneumatic Sect, and is said to have been founded by Chrysippus (236 B.C.) of Cnidus, a famous Stoic philosopher. The Pneumatists denied the elementary humors as the constituents of the body, but laid stress on the qualities of those humors, heat, cold, dryness and moisture. They claimed that the ruling element in the body was the pneuma, or spirit *(spiritus),* and this idea becomes prominent in a number of medical theories for many centuries later. A member of this school added to medical nomenclature the diagnosis of putrid fever which is identical with modern infections or the sepsis of Aristotle. The sect of the Eclectics adds a seventh to the group just described. It was founded in Rome by Agathinus of Sparta (90 A.D.) who attempted to unite the

existing sects by accepting the good of all the existing theories. These Eclectics, or the "Choosers," put forward no new theories of their own.

Pliny and Celsus

Our knowledge of the medicine of the first two centuries of the Roman Empire depends but little on the writings of the authors themselves but largely on the books of two men, Pliny and Celsus. Neither of them practiced medicine, and Pliny was not a physician. Both of them wrote histories of human knowledge, and had much to say of medical affairs. Caius Plinius Secundus, the Elder, was born in northern Italy in 23 A.D., and died at Stabiæ on the Gulf of Naples where as commander of a Roman fleet he was watching the first eruption of Vesuvius in 79 A.D. He criticized his medical contemporaries and their methods, and his book, *Naturalis Historia,* is a general natural history and not a book on medicine. He throws a side-light on medical practices, however, in his description of the value and use of natural hot springs as a means of healing in his time, and he classifies the resorts in the Empire and colonies, especially in Europe, which are still used, as saline, sulphur-bearing, ferruginous, and those containing alum or niter. The baths at Aix-les-Bains, Wiesbaden, Baden and others in the Pyrenees, Aquitania and in Italy were already well-known and patronized. Later the Roman colonizers of Britain developed a typical hydrotherapeutic resort at Bath in England. Pliny's book is a compilation of known facts. A manuscript of the eleventh

century, *Codex Vesontinus,* exists in three portions in Rome, Paris and Leyden. The first printed edition known is by J. Spira in Venice in 1469.

Aurelius Cornelius Celsus was also a Roman citizen, born probably in Rome, and was an older contemporary of Pliny. His book also is a kind of encyclopedia of all knowledge, and written in the best classical Latin. Its scope is shown in its title *Artium libri.* Eight of its chapters were devoted to medicine and these only have survived under the title *De Re Medicina.* There is a manuscript of the tenth century in the Ambrosian Library in the Vatican and another dating from the twelfth century in Florence. The book was first printed in Florence in 1478 by Nicolao from a manuscript only discovered in a church in Milan some thirty-five years previous (1443), and since lost. It passed through many editions (sixty) in the next two centuries, being printed in a second edition at Milan in 1481, in Venice by Aldus in 1525, and later by Elzevir in 1657. The treatise gives a resumé of the work of the leaders of medical thought before the time of Celsus, who had a great influence on the medical practice of the fifteenth and early sixteenth centuries when his book was made generally accessible by the new art of printing. The original books of seventy-two authors mentioned by Celsus have been lost, and this book is our only source of information concerning them.

Celsus mentions several medical procedures earlier than any other writer. Among these are the use of nutrient enemata, the operation on the eye for cataract, the operation for cure of hernia, and a classical de-

scription of the operation for vesical calculus. He advocates the use of the ligature to control hemorrhage which had to be rediscovered by Ambrose Paré in the sixteenth century before the practice became universal. Surgery in Rome was a highly developed art before Galen's time. The excavations at Pompeii have produced more than two hundred surgical instruments of different uses including probes, knives and specula of various kinds. Celsus has given us a description of the required characteristics necessary for a physician to be a successful surgeon in those early days before infections were understood and before anesthetics were discovered: "A surgeon must be young; he must have a firm and skilled hand which must not tremble; he should be able to use the left hand equally well as the right; his eyesight, clear and piercing; his heart free from fear and from pity, thinking only of the cure of his patient; he must hold himself free from influence, from the cries of his patient tending to make him hurry the operation, and refrain from cutting less than is necessary; he must conduct his operation as if the complaints of the patient did not reach his ears or his intellect."

Galen

Such was the state of medicine in Rome in the year 162 A.D. when Galen, aged thirty-two, came to town. Imperial Rome for years had welcomed any new philosophy, any new religion, or rather the worship of any new god or goddess. The Romans were tolerant of any new idea but resentful of attempts to destroy any

of the older and accepted cults. It was no shock to the Roman intelligence that seven sects of physicians should present rival claims for patronage. Rome was the center of the civilized world surrounding the Mediterranean, the seat of the imperial government. Every known deity had its temple and was worshiped more or less promiscuously by all the people. The assistance of the gods, or of any god, was sought for special help by any citizen. There was no one god to whom all the people turned to pray for help in the many complications and troubles of life.

Christianity was known as an almost secret religion. Claiming the poor, the slaves and the uneducated as its votaries, Christianity was in consequence looked upon with suspicion and as a possible menace to the government, and for this reason the Christians were persecuted as early as in the reign of Trajan (70 A.D.). The early Christians had a message for the world; but the world was unprepared to adopt this message as a new philosophical religion and add it to those already in existence; much less was the world prepared to discard all the other gods and goddesses and adopt the single God of the Christians as the one and true deity to rule over the minds and bodies of men in this world and over their immortal souls in the world to come. Among the hundreds of temples with their gods and goddesses, medicine with only its seven sects must have made a weak appeal, and one school more or less would not seem to be of any significance to the man in the street, or even to a member of the Roman Senate.

The educated Roman was bled in the spring and in

the fall. He enjoyed daily exercises followed by massage and baths; if ill of a chronic disease, he visited some of the hot springs that abounded throughout the Empire. He took preventive medicine daily, the form in general use being known as *theriaca,* compounded of seventy-eight different drugs, some vegetable, some animal products, some actively purgative and others diuretic or emetic. *Theriaca* was therefore a compound of conflicting drugs which more or less counterbalanced one another and were further controlled by the addition of opium. It contained also the flesh of the viper, a noted antidote for snake-bite, which is the precursor of the modern opotherapy (organotherapy). Its use was continued in a modified composition until the early nineteenth century. The popular advisers in medical affairs included gatherers and pedlers of herbs, dealers in salves, venders of amulets, love-philters and abortifacients, astrologers, midwives, attendants and masseurs from the baths, and quack specialists, particularly of diseases of the eye. Most of the physicians were Greeks or of Grecian education, and many were slaves or freedmen. Nothing was added to medical knowledge by native-born Romans except in regard to public health and the hygiene of the home and of cities. The houses were open and well ventilated, the cities were provided with sewers and a supply of pure water by large aqueducts, and the Romans practiced cremation of the dead. These habits of a hygenic life had more influence for good on the health of the Romans than can be claimed for the medicine of the time, however much we praise Hippocrates and his rediscoverer—Galen.

Militant Rome when mistress of the world was no more successful than intellectual Greece had been in controlling the inherited traditions and customs of the homely medicine often based on superstition and magic which was handed down largely by the womenfolk to succeeding generations, especially to the children during their most impressionable periods of nursery life. The educated physician to-day is handicapped by the same influences in carrying out the best advances in preventive and curative medical practice as were his predecessors for twenty-five hundred years. There is an improvement of course in the degree of opposition but no change in kind. An extreme case in evidence is the murder of a young medical practitioner by a father made insane because of the death of his child from diphtheria after a dose of antitoxin had been given in a desperate attempt to save the child, who had been left without remedy and without skilled care for one week before any physician was called to see it. The quacks and medical harpies continue to flourish and fatten on the unwary and ignorant to-day as they did in Greece and Rome and in the period of the Renaissance. These fakers change their dress and their methods, but the promise of a cure from any one still has for many an appeal which can not be overcome by an honest statement of truth that can promise little though it may accomplish much.

It was no miracle that Claudius Galenus, the son of Nicon, an architect and geometrician, should have been born in 130 A.D. at Pergamum in Mysia, Asia Minor, lived at Rome for thirty-five years a celebrated phy-

sician, and died in 200 A.D. in his native city. Galen's birthplace was a center of learning which had been founded by Attalus who became king of Pergamum shortly after Alexander died and his conquests were divided among his generals. In their efforts to increase the growth of their respective libraries, the competitive bidding for scholars and books between Attalus of Pergamum and Ptolemy of Alexandria became marked. The latter forbade the exportation of papyrus from Egypt, thus compelling the Greek scholars to find a substitute writing material. *Pergamentum* (or parchment)—a noun that celebrates the name of the city of its creation, and an improvement over papyrus—was the material invented at the Mysian capital. The library at Pergamum afforded the young Galen opportunity for study in mathematics and philosophy, and later in medicine, of which, under the stimulus of his father, he made the best of use. Galen subsequently studied and traveled from one medical center to another in the Greek world. Becoming interested in the writings of Aristotle, he adopted for himself the philosophy of the Stoics. He studied at Alexandria for some time and returned to Pergamum after nine years of travel only to set out for Rome four years later because of a serious riot in the city of his home. At this time he remained in Rome for about five years, and has been severely criticized for leaving during an epidemic of the plague. Other writers believe that he left because of the opposition of his medical colleagues. It would seem unfair to accuse him of personal fear, for he returned later to be with the army of the Emperors Marcus Aurelius and Lucius

Verus during a recrudescence of the same disease of which Verus himself died on the journey to Rome.

Galen was a positive man who was given in his writing to bragging and self-praise. He attacked every one of the existing sects of medical practitioners and sounded a note of reform in what would now be phrased "Back to Hippocrates." He referred to the Methodist Sect with biting ridicule as the "asses of Thessalus." It is easy to understand that he might feel that he was himself persecuted by his profession. He was made personal physician to Marcus Aurelius, and found time and opportunity to devote himself to medical research and writing. Two types of pictures of Galen have come down to us: one that of a bearded physician probably very like to his contemporaries, and another which appeals to one as more consonant with his pugnacious and assertive character. This latter has been reproduced in the accompanying portrait from the marble bust in the London College of Physicians. Galen appears as a clean-shaven and dignified man not unlike any distinguished member of the Roman Senate. (Figure 3.)

Starting with the anatomical knowledge contributed by the Alexandrian School he enlarged upon this knowledge and made still greater contributions. For his own anatomical research he resorted to dissection and vivisection of animals, particularly of apes, monkeys, pigs and dogs. Dissection of the human body was regarded by the Romans, as it had been by the Greeks, as sacrilegious. For this reason Galen founded his anatomical knowledge entirely on the anatomy of animals. Galen's most valuable anatomical work was done in investigation

From an engraving by W. Skelton of marble bust in College of Physicians, London, published in Pettigrew's MEDICAL PORTRAIT GALLERY, in the Collection of The New York Academy of Medicine

Figure III

GALEN

of the nervous system. He described the meninges or coverings of the brain, gave permanent names to several parts of the brain, and showed that nerves may be purely conductors of sensory impulses to the brain, or purely conductors of motor impulses to the muscles from the brain, or that they might be a mixture of both. Nerves may originate in the brain or in the spinal cord, and of the twelve pairs, called cranial nerves, originating in the brain itself Galen described and named seven. He also described a part of the nervous system which exercises influence over involuntary functions called the sympathetic system. Besides his work on the nervous system he made skilful and careful dissections of many of the muscles and gave names to several of them, such as the popliteus behind the knee, and platysma myoides under the skin of the neck. Concerning the heart and blood-vessels he seemed, considering his talents, to have strangely misconceived their function. In this way he retarded true knowledge concerning them because his word on all medical subjects was considered authoritative for centuries. He did point out the differences between the arterial and venous walls, however, showing the greater thickness and elasticity of the arteries, and disproved the theory of Erasistratus that the arteries contained air. He also gave good descriptions of some of the heart valves. But he held that the veins originated in the liver, that the expansion not the contraction of the heart was its important function and that there were minute pores between the chambers of the right and left heart through which blood passed. While he asserted that the arteries and veins communicated by

means of minute branches and thus showed his knowledge of one of the essentials of the law of the circulation, he seems not to have even suspected that the blood circulated. When Harvey described the circulation of the blood fourteen hundred years later, one of the greatest obstacles in obtaining credence for his demonstration was the fact that it was contrary to Galen's teachings.

Galen was one of the first to do work in experimental physiology. His investigations of this nature concerned especially the central nervous system. He was impressed with the influence which the brain exercised over the rest of the body, and asserted that the seat of the soul was in the brain. He proved by experiment that motions of the body were initiated in the brain, and bodily sensations were perceived by the brain, and that the spinal cord and nerves acted as conductors of this stream of impulses to and from the brain. He demonstrated this by cutting the spinal cord transversely at different levels, and showing that paralysis or loss of sensation and motion occurred below the section. A nerve is given off from each of the tenth cranial nerves in the upper part of the chest near the collar-bone, which ascend in the neck to the larynx, and are called the recurrent laryngeal nerves. Galen showed that the cutting of the recurrent laryngeal nerves resulted in aphonia or loss of voice.

Galen was a most industrious worker in trying to discover by experiment the secrets of bodily processes. In the absence of experimental explanation he was not averse to recourse to philosophy or to his imagination to find the explanation of phenomena which he did not

understand. Thus in an effort to explain life itself he endorsed the hypothesis of Plato that the body was animated by a series of hypothetical "spirits"—natural spirits originating in the liver, and vital spirits originating in the heart which were converted to animal spirits by the brain.

Many of Galen's writings are devoted to clinical medicine, and in these he remains throughout consistently in agreement with Hippocrates and the Hippocratic methods of observing the natural course of disease. He divided disease into three classes: first, those affecting simple tissues, such as muscles, ligaments and nerves; second, those affecting compound tissues like the heart and lungs, and third, those affecting tissues generally, especially the four humors. Symptoms, he claimed, could explain from what the patient was suffering (diagnosis), and also what would happen to the patient (prognosis). He considered symptoms either the result of altered function of the tissues, of altered quality of the tissues, or a disturbance of both of these. To differentiate one disease from another he admonished physicians to familiarize themselves with the symptoms which arose from disturbance of different parts or organs. Disturbance of the lungs, he pointed out as an example, produced pain in the chest, difficulty in breathing, and cough. These were localizing symptoms and pointed to the lungs as the seat of the disease. Galen made so many fine distinctions in the nomenclature of diseases that his followers even in the thirteenth century had great difficulty in recognizing or defining them. The theory of putridity as an addition to the classification of

fever, he accepted, and he showed that inflammation of a part or organ was characterized by four symptoms: heat (calor), redness (rubor), swelling (tumor) and tenderness (dolor). He differentiated pneumonia from pleurisy, and gave a good description of pulmonary tuberculosis, mentioned that it was infectious and advised a diet for it of milk in large quantities, sea voyages and change of climate to dry elevated places. He described gout and pointed out its frequent association with stone in the kidney.

In discussing the treatment of disease he sometimes obscures his real method by enlarging on his own cleverness and successes. We find that he familiarized himself with many drugs, going to the pains of collecting medicinal plants in distant places; also, he used opium, colocynth, hyoscyamus and many other drugs with the understanding of their effects of a modern physician. He inclined toward the use of many drugs together in what are spoken of now as "shotgun" prescriptions, of which his universal remedy, *theriaca,* is a good example. It is said that Marcus Aurelius presented him with a gold chain and medal inscribed *"Antoninus Rom. Imp. Galeno Med. Imp."* (Antoninus, Emperor of Rome, to Galenus, Emperor of Medicine.) to commemorate the compounding of this specific. He secured a certain degree of antisepsis when a young man by treating the wounds of gladiators at Pergamum with dressings soaked in wine. One of his contentions, which exercised a bad influence in surgery, was that suppuration, or pus formation, was necessary to the healing of wounds. Pus forming under these conditions he called "laudable pus."

The modern surgeon accords scant praise to any pus and bends every effort to prevent its formation.

Galen's writings contain a great deal of philosophical discussion. Living in Rome in the second century A.D., he must have been familiar with the religion of the Christians. He was a follower of Plato and Aristotle and endorsed the dictum of the latter philosopher that nature has never created anything without its having a useful purpose. Though a Greek, living at the time when the religion of the Greeks was polytheistic, he often speaks when considering some of the remarkable and complex processes of the body, which he has demonstrated, of his respect and reverence for a creator who has designed so wisely. He regarded his work in demonstrating such processes as the most sincere way of showing respect and admiration for an all-wise God. He added nothing to the prevailing theories on which the humoral pathology of the School of Hippocrates was founded, and adopted also the three spirits of Plato, the *strictum* and *laxum* of Themison to which he gave new names of plethora and cacochymy. He placed blood above the other humors in importance, and he was no extremist in his use of bleeding or other therapeutic measures.

Galen's was one of the most brilliant intellects ever applied to the problems of medicine. An indefatigable worker, he wrote voluminously, and possessed the power of expressing himself clearly and interestingly. Being unpopular with the rank and file of the profession, his work was not appreciated and was given little attention by his contemporaries. In the fourth century A.D. phy-

sicians of better education began to appreciate his wisdom, but his work was lost sight of in Europe soon afterward. Medicine was in bad straits throughout the Middle Ages, and Galen was almost forgotten except as represented by the stealings of other writers. His ideas and theories were preserved in translation by the Arabian physicians, and his books in Greek were stored for years by monks in a few monasteries although neglected and unread by their possessors. Toward the end of the Middle Ages his writings again came into the hands of the profession and his opinions became virtually the law on medical subjects. In many ways this reacted for great benefit to the profession, but it was absurd to expect that one man in his lifetime might learn in the second century of the Christian era the all of medicine, or that he should not form some erroneous as well as some truthful conclusions concerning such an intricate subject. Galen formulated three ideas which became Galenic tradition and acted as a check to further investigation and progress in medicine: first, the anatomic assumption that the blood passed from the right to the left ventricle through invisible pores in the cardiac septum; second, the reiteration of the theory of Plato that there were three spirits in the blood, the natural spirit found in the liver, the vital spirit originating in the heart, and converted in the brain to animal spirit, and finally, that the formation of pus was an essential feature of the healing of wounds.

Galen wrote many books which made up a large collection of the knowledge of his time. Many were burned during his lifetime in the fire of the temple of peace and

the adjacent apotheca at Rome toward the end of the reign of Commodus. There have survived six books on anatomy, seventeen on physiology, six on pathology, fourteen on therapeutics, thirty on materia medica, and sixteen on the pulse. A manuscript of the fifteenth century, the *Pergament Codex,* is in the library at Dresden, and another, the *Codex Marcianus,* is now in Venice. An edition was printed in Latin in Venice by P. Pintium in 1490. His works were first printed in Greek by Aldus in five volumes in 1475, later in 1525, and in the Latin translation by Giunta at Venice in nine different editions between the years 1541 and 1625. There is no complete translation in any modern language.

IV

RHAZES AND AVICENNA

The Aristotelianism and Galenism of the Moors and the Renaissance in Italy

THE progress of the medical science of the Greeks came to an end with the death of Galen. The rival schools at Alexandria and Pergamum and others continued to function but in a very desultory way. No medical authority appeared to carry on the work. Galen did not create an immediate following, and apparently there never was a school of medicine at Rome. Rome itself was losing political importance, which fact, about one hundred years after Galen's death, resulted in the removal of the capital to Byzantium on the Bosphorus by Constantine in the early part of the fourth century A.D. The Roman emperors either singly or in pairs, or even by threes, continued to rule over Italy and Rome as well as over the new capital until 395 A.D. when the Eastern Empire was separated from the western portion ruled from Rome. The final fall of the Western Roman Empire to the conquering Visigoths under Alaric in 476 A.D. marked the death of all medical advance in Rome and western Europe. The best of medical thought had long since migrated to the new capital at Constantinople with the departure of the emperors from Rome, and the future of the medicine of the civilized world of the Greeks and Romans de-

pended on the fate of one city alone. This situation was made more acute by the foundation of the Christian religion as the official State Church of the Empire in 330 A.D. by the Emperor Constantine under the influence of his wife, Fausta.

Scientific medicine received a hard knock when Constantine in the year 335 closed all the *asclepieia* along with the other pagan temples, for these temples had long since become sanatoria for the cure of the sick and injured under educated physicians and had lost their religious and priestly character. The schools of medicine suffered in like manner, inasmuch as the rise of the new dominant religion brought about a conflict between the old and the new. Pagan polytheism did not yield without a struggle, and the final result was a religion Christian in name but often pagan in form. Many of the temples became Christian churches, and much of the pagan ceremonial was absorbed and adopted by the resulting church. This revolution absorbed the attention of the men of intellect and led men to the exclusion of all else to think of and discuss the many problems of philosophy, of ethics, of creed, of church government, of belief, of the interpretation of the new mysteries which were involved in the momentous changes. Medicine almost disappeared from the thoughts of men as the religious questions multiplied in number and in complexity.

Constantine was succeeded by three sons ruling in concert, and when the survivor of these died in the year 361 his cousin and brother-in-law, Julian, succeeded to the throne. Julian was a very remarkable man, an opponent of the recent religious revolution, a soldier

who had been kept on the frontier with the army for the greater part of his active life presumably because of his reactionary tendencies. On his accession he disestablished the Christian Church, and during two years attempted to restore pagan polytheism. At the end of this period he was killed by one of his own soldiers in a battle with the Parthians in Asia Minor and has been anathematized as the Apostate ever since. Julian must be honored by physicians as having shown the first effort after one hundred and sixty years of eclipse following Galen's death to relight the torch of medical learning, as he commissioned Oribasius to formulate the knowledge of the ancient physicians into a new treatise.

Oribasius, Ætius, and Alexander of Tralles

Oribasius, like Galen, was a native of Pergamum and was born in 325 A.D. He had been a student at Alexandria and at Athens and became the physician of Julian prior to the latter's succession to the Imperial purple. He wrote an encyclopedic treatise of medicine in seventy-two books, some of which have survived and prove a source of knowledge of the works of his predecessors. A Greek manuscript of the *Collectio Medicinalia* is in the National Museum at Pesth and another of a Latin translation of the sixth and seventh centuries in the library at Paris. This was printed first in 1555 by Aldus at Venice. The *Synopsis* exists in manuscript as *Codex Laurentianus* of the twelfth century and was printed by P. Manutius at Venice in 1554. Both were translated into French and published in six volumes by Daremberg

at Paris, 1851-1876. As a compilation of Galen the books of Oribasius have helped to preserve the writings and knowledge of that master mind. Byzantium was the home of two other encyclopedists who rewrote and copied the books of Galen without adding any new ideas to those of that author. Ætius, a native of Amida (modern Diarbekir) in Mesopotamia, the physician to Justinian I who was emperor from 527 to 565 A.D., and Alexander of Tralles in Lydia, born 525 A.D., a contemporary, both wrote such treatises which have been partly preserved. These two Greek physicians resided in Constantinople and are known to have been Christians. Neither is known to have added to the knowledge of their time, but they have thrown a side-light on medicine in the sixth century by their endorsement of amulets and magical remedies. Byzantium in this way continued to practice medicine in the manner of Galen and preserved the traditions of that author in an incomplete form and changed by transmission through the restatement of physicians less able than the author. The manuscript of the *Biblia iatrika* of Ætius is to be found in Florence. The first edition in Greek was printed at Venice by Aldus in 1534; the edition of Cornarius was printed in Latin at Basel in 1533-1535. A manuscript of Alexander of Tralles which gives a Latin translation made in the ninth century is at Monte Cassino. It was printed in incomplete form at Lugdunum in 1504 by Franciscus Fradin.

Byzantium gave a further but involuntary impetus to the preservation of the Galenical books through the treatment accorded to the schism of Nestorius by the authorities of the established church. Nestorius, patri-

arch of Constantinople, denied the virgin birth of Christ, and taught that Mary should be styled Mother of Christ and not Mother of God. In this form *(circa* 430 A.D.) the controversy of the twentieth century between the modernists and the fundamentalists began. Nestorius had many followers including educated philosophers and physicians, and all were banished from the Empire and driven to the East. The Nestorians were a peaceable communion and were welcomed by the Syrian and Persian peoples and lived for many years in amity with their surroundings, with Jew and Gentile, and later with the Mohammedan conquerors of the country. The Nestorian Church spread eastward to China and the Indus; Greek physicians gained control of the hospitals and school at Edessa in Mesopotamia, and later at Gondisapor in Persia, and preserved the texts of Hippocrates, Aristotle and Galen, which they translated into Syriac.

The scourge of war destroyed all hope of posterity securing the inheritance from the libraries of the museum and serapeum at Alexandria. This collection of papyri and parchments had twice been renewed in the past: once when destroyed by accidental fire at the time when Julius Cæsar's army conquered the Egypt of Cleopatra and Ptolemy, her brother, and again when Caracalla destroyed the museum and slew many of the inhabitants in revenge for some poems in which he had been caricatured. The Emperor Antoninus had caused a large part of the library at Pergamum to be removed to Alexandria to replace the losses of the first fire, and the second had only a temporary effect also. In the

year 640 A.D. the Sultan Omar ordered his general, the Emir Amru ben-el-Ass, to destroy all the books because if they agreed with the Koran they were unnecessary, and if they differed they were harmful. The chief attraction of Alexandria for scholars was gone, and that school after nine hundred years ceased to exist.

Paul of Ægina

The last physician of repute to reside and teach in Alexandria was Paul of Ægina who flourished in the middle of the seventh century and belongs to the Byzantine culture which was absorbed by the Arabs. His book contains nothing newer than the ideas of Galen, and after being translated from the Arabic, it became one of the text-books of the physician of the fifteenth and sixteenth centuries. A manuscript in Latin dating from the ninth or tenth century was discovered by Daremberg in the nineteenth century in Monte Cassino. A Greek text was printed by Aldus in Venice in 1528. Two manuscripts in Greek of the eleventh century are at Paris, and a Latin text was printed by Colinaeus at Paris in 1532. The Sydenham Society published an English edition in three volumes in 1844-47.

The Mohammedan peoples were very different from the Germanic conquerors of Rome and western Europe,—the latter were barbarians in fact, while the followers of Mohammed as soon as their conquests were made secure endeavored to assimilate all that was valuable in science, literature and especially in medicine

with which they came in contact throughout the Græco-Roman world from Mesopotamia to Egypt along the African coast and into Spain. The chief promoters of Grecian culture were the Abbaside caliphs of Bagdad who ruled from 750 to 1258 A.D. They showed a decided interest in medicine and went to great pains and expense to encourage its growth. They obtained from the Nestorians copies of the Greek medical texts of Hippocrates, Galen and Dioscorides, and employed Nestorian physicians to make Arabic translations of these. In addition they sent emissaries to foreign lands to obtain missing parts of the Galenic and Hippocratic writings. The first translations were made by Abu Leid Honein who was known to the Latins as Johannitius, and who lived from 809 to 873 A.D.

The Arabian rulers endowed and supported many hospitals. These were often well built and well arranged and provided every convenience for the comfort and care of the sick. Perhaps the largest of these hospitals was built by one of the caliphs in Bagdad during the tenth century. This was under the charge of twenty-four physicians who excelled in some special branch of medicine, and was organized in different services devoted to fever cases, eye cases, surgical cases, *etcetera.* The founder stipulated that it was for all classes without regard to religion. The best of food was provided, as well as readers and story-tellers for the entertainment of the patients. On discharge a patient was given a sum of money to enable him to continue his convalescence before returning to work.

The foundations of Grecian medicine passed in this

manner into the friendly hands of the Arabian physicians, with whom Hippocrates and Galen remained for five centuries as cherished masters of the medical art before they were returned in a new dress to western Europe in the eleventh and twelfth centuries. In the transition the original Greek underwent translation into Syrian, then into Arabic, sometimes into Hebrew and finally into Latin. But always the Arabians gave credit to Galen and Hippocrates as the originators of their craft.

The trade of the apothecary probably originated with the Arabs who spoke of the apothecaries as *sandalani* because of the frequency with which sandalwood was used in the Arabic preparations. The Arabs were the first to develop the art of preparing drugs for medicinal use. In many of the cities the apothecaries were kept under strict supervision regarding the drugs they dispensed and their purity. The Arab writers paid a great deal of attention to drugs and introduced many new ones such as senna, camphor, rhubarb, myrrh, aconite, cloves and mercury, and originated preparations such as syrups and juleps. Later the pharmacopœia of western Europe—a list of all useful drugs with their descriptions, methods of preparation and uses—was founded upon that of the Arabs.

Alchemy, the foundation of modern chemistry, probably had its source in Arabian medicine. The chief incentive in alchemy was, of course, the discovery of a method of transmuting baser substances into gold, and the production of an elixir of life which would cure all disease and confer eternal youth. In the eighth century a

man named Geber was supposed to have discovered aqua regia and nitric acid and to have described methods of filtration, sublimation and distillation. The story of alchemy is involved with astronomy inasmuch as the seven known metals were supposed to be formed in the earth under the influence of the seven planets. The sun, moon, Mars, Mercury, Jupiter, Saturn and Venus corresponded to the metals gold, silver, iron, quicksilver, tin, lead and copper. Thus the alchemists searched for the substance which, if subjected to the proper planetary influence, would become gold. They expected that when they could find a potable gold they would have discovered the elixir of life.

The Arabians were interested chiefly in the use of drugs, the diagnosis of disease and its treatment. They were very little interested in anatomy and physiology. Their religion forbade dissection of the human body, and they contributed nothing to anatomical or physiological knowledge. There was nothing noteworthy about their surgery except their decided preference for the cautery to the knife. The first attempt at the licensing of physicians was made in Bagdad. A physician called Sinan, in the latter part of the tenth century, examined all of the practitioners in and about that city, and granted licenses to practice medicine to about eight hundred of them.

Rhazes

Two of the Arabian physicians stand out preeminently above the others as having added something to medical knowledge. Both were confirmed adherents of the

Galenical tradition. Abu Bakr Mohammed ibn Zakariya was born at Raj in Khorassan (860-932 A.D.). He is known as Rhazes and wrote a text-book on medicine called the *Continens* which deserves recognition because of his ability to describe disease. The first accurate and complete description of smallpox, differentiating it from measles, comes from Rhazes, and he speaks of its cause as some ferment which invades the body, as if he suspected a bacterial origin of disease. He gave the description of many new drugs and probably introduced the use of mercurial ointment. He treated fevers, especially smallpox, with compresses wet in cold water, used cooling baths and gave cold acid drinks using diluted vinegar, and fruit juices such as lemons, pomegranates, apples and gooseberries. Rhazes bled his patients with more discretion than was advised by his Greek authorities. Two hundred twenty-six books, adding to and transcribing the works of Galen, Ætius, Pliny and Paul Æginetus directly into Arabic from the original Greek, were written by Rhazes. The Arabic text was never printed, and exists in a complete manuscript in the Escurial library. Part of this work was issued from a Latin translation by Ferragius done in the thirteenth century, the manuscript of which is lost, and printed by Jac Brittanicum at Brescia in 1486, and the last edition is that of Venice in 1492. Rhazes was the chief physician of the Hospital Marastin at Bagdad but practiced also at Alexandria and Madrid which were under Moorish control. He was a chemist, discovered sulphuric acid and led the Arabian physicians to many pharmaceutical improvements.

Avicenna

One of the most able and best known of the Arabian physicians was Ibn Sina called generally Avicenna. Like Rhazes, he was a Persian and was born in 980 A.D. at Afshena in Bokhara. He was a man of many-sided character and a *bon vivant*. Precocious in his youth, he was recognized as something of a prodigy when at seventeen, after having studied the theory of medicine for a year or two, he was called into consultation in the case of one of the caliphs. His diagnosis was so correct, and his treatment so successful that he immediately became famous. He interested himself in geology and produced a book on the formation of mountains which has earned for him the title of the Father of Geology. Many of his writings were on philosophical as well as medical subjects, and he wrote poetry as well as prose. Avicenna during his career occupied political positions of great responsibility. On one or two occasions he was in jail as a result of political intrigue. It is said of him that he was one of the first philosophers to take to strong drink. His portrait represents a typical bearded Persian with turban and Oriental dress who holds an open book in his hand. (Figure 4.)

Avicenna's medical writings which have survived to modern times are contained in a tremendous book called the *Canon*. In this he gave his own interpretation of Galen's work, and reconciled it with the Arabian knowledge of medicine in his day. In it are contained good descriptions of diabetes and anthrax and the first description of the guinea worm, a parasite which burrows un-

From a print in Author's Collection

Figure IV

AVICENNA

der the skin and causes an abscess. He advocated the Hippocratic method of reducing spinal deformities by forcible reduction, regarded surgery as an inferior art, as nothing more than a method of treatment to be directed by a physician, and urged the use of the cautery instead of the knife. There are several fine manuscripts in the British Museum and one in Hebrew of the thirteenth century in the Vatican. Nine editions were printed in the fifteenth century, the first at Milan in 1473, and all are therefore prized medical incunabula. The edition of 1593 was printed at Rome in the original Arabic. The best edition in Latin was printed by Guinta at Venice in 1582. The authority of Avicenna with the physicians of western Europe during the Middle Ages ranked even higher than Galen's, although his contributions to medicine in no sense rank as high. He was undoubtedly a great clinician but made no great discoveries as did Galen by investigation and experiment. His influence was in a sense harmful in that it encouraged physicians to philosophize upon knowledge that they already possessed rather than to hunt for and discover new facts. Avicenna, leaving a reputation for dissolute living, died at the age of fifty-six, earlier perhaps than he would have had he followed a straighter and narrower path.

The School at Salernum

The third source from which we have inherited the books of the early medical writers is associated with the School of Salernum. The language of the common people of southern Italy was Greek until the thirteenth

century, and the cities were under Greek and Byzantine rather than Roman cultural influences; in fact, southern Italy remained for a long time a part of the Eastern Empire. The School of Salernum was one of the bright spots of scientific medicine during the Middle Ages. Salernum is situated on the Bay of Naples, and always had a reputation for the beauty and health of its climate. People came from all parts of Europe to the city as a health resort. Because of the opportunities offered, able men came there to practice medicine. Gradually the profession at Salernum achieved a reputation for its ability, and physicians came to learn medical methods from the local practitioners. In this way the School of Salernum probably had its foundation, although the exact date is not known. Salernum came under the influence of Arabian medicine chiefly from the activities of translators in Spain who produced Latin versions of the Arabic and Hebrew texts used in the centers of Arabian culture and medicine at Seville, Toledo and Cordova where Albucasis the Surgeon, Avenzoar, and Averroës, "the soul of Aristotle," were prominent. Gerbert, who later became Pope Silvester II (999-1003), stimulated the work of Gerard of Cremona and Constantinus, and they brought Hippocrates and Galen to Europe by their translations of the Arabian writers.

Constantinus, the African, was an Arab born in Carthage in the eleventh century (1018-1087) who became converted to Christianity early in life. He traveled extensively in the East, making a study of Arabic medicine and the Arabic medical authors. He came eventu-

ally to Italy and entered the Benedictine monastery at Monte Cassino at Salernum when the ruling abbot was Desiderius who later was elected Pope Victor III. While there he made Latin translations of Haly Abbas, Isaac Judæus and the Arabic versions of the works of Galen and Hippocrates. It is said that some of these translations he gave out as his own original work. In his time the language of the profession had become Latin and as his writings were in this language they were widely read. Constantinus' name was also associated with the School of Salernum where he is thought to have taught for a period. The teachings of the school were often Methodist in practice, but were founded on Galenic and Hippocratic authority. The relations of the school to the clergy were always amicable, and Salernum never came under clerical dominance.

Anatomy and physiology at Salernum were taught according to the work of Galen. Some of the members of the school published elementary works on anatomy founded on the dissection of pigs. Treatment rested largely upon the Hippocratic method based on experience and common-sense measures. In diagnosis emphasis was placed upon inferences drawn from the character of the pulse and of the urine. These inferences in the light of the knowledge of the present day were largely erroneous.

One of the most celebrated productions of the school was a poem entitled *Regimen Sanitatis Salernitanum*. In this is given in rhyme much advice about diet and hygiene. The date of its origin is unknown but it was published first in Latin in 1484, and passed through two hundred

and forty editions in different languages. The following are some of the verses translated by Doctor John Ordronaux:

"If thou to health and vigor wouldst attain,
Shun weighty cares—all anger deem profane,
From heavy suppers and much wine abstain.
Nor trivial count it, after pompous fare,
To rise from table and to take the air.
Shun idle noonday slumber, nor delay
The urgent calls of nature to obey."

The words of the *Regimen Sanitatis Salernitanum* warn against quacks, or quacksalvers, which term is an adaptation of a common name of the mental mercury, quicksilver, and goes on to describe and advise the regular physician in the following verses:

"Let doctors call in clothing fine arrayed,
With sparkling jewels on their hands displayed;
And if their means allow let there be had,
To ride, a showy rich-attired pad,
For when well dressed and looking over nice,
You may presume to charge a higher price,
Since patients always pay those doctors best
Who make their calls in finest clothing dressed,
While such as go about in simple frieze,
Must put up with the meanest grade of fees;
For thus it is poor doctors everywhere
Get but the smallest pittance for their share."

The following pen picture of the physician of the early sixteenth century is drawn by Heinrich von Nettesheim, of Cologne (1486-1533): "The physician is usually a foreigner, perhaps Jewish or Moorish in nationality. He is dressed expensively with many seal rings on his fingers. He speaks emphatically, using semi-

barbarous words as well as Greek and Latin. He examines his patient, feels his pulse, looks at his tongue, palpates his abdomen and chest, observes his secretions, inquires concerning his manner of life and habits, his regular diet, and sometimes, if necessary, questions concerning more intimate relations of life. In this way he is able to measure the balance existing between the humors of the body. He talks sternly and with authority, and prescribes closely the treatment to be followed, including bleeding, laxatives, ointments, gargles, powders, syrups, and Galenical compounds of practice which are given in addition to the universally used *theriaca.* If the disease is slight he will prescribe massage, copious incantations, and that the patient rest in a swinging-bed. At the end of the acute attack he will order a course of baths and a sojourn at thermal springs, a carefully selected diet, and a change of air. He will himself oversee the preparation of his prescriptions by the venders of drugs. In cases of doubtful end he will cause to gather the College of Physicians, and demand a consultant."

Legend would make us believe that not a little of the practice at Salernum was done by women who are spoken of as the "ladies of Salerno," and that their work was largely confined to obstetrics, gynecology and the cosmetic art. Several of them wrote books on these subjects, the most celebrated of which was alleged to be the work of Trotula, or Dame Trot. This treatise, called *De Passionibus Mulierum,* exists in manuscript in Breslau dating from the fifteenth century. It was printed by Aldus in 1547 at Venice.

Members of the School of Salernum were also contributors to the movement which tended toward the improvement of the status of the surgeon. This began in the twelfth century. Surgery up to this time was in the hands of the so-called barber-surgeons, and was regarded by physicians generally as an unattractive art to be practiced under their direction by persons of inferior education. In medieval times surgeons were divided into three classes: first, the surgeons in the long robe who were few in number but who had the same education as physicians and who were in fact physicians practicing surgery; second, the barber-surgeons who were legally entitled to do hair-cutting, shaving, cupping, to apply leeches, to extract teeth, and to do simple cutting operations such as the incision of boils; finally, there was a class of traveling artizans, often quacks, who removed bladder stones by cutting operations, and operated for hernia, or rupture, and for cataract. At times these latter specialists were members of the same family whose operative technique was held as a secret to be handed down from generation to generation.

About the twelfth century a number of able men began to interest themselves in surgery and to enlarge its field by devising new surgical methods and types of operation. These operations often required a physician's knowledge of anatomy and of medicine in general. The barbers held tenaciously to their surgical prerogatives and organized themselves into guilds to retain them. The medical faculties in the different countries strove to exercise control over the barber-surgeons and to retain the right to license only such barbers to practice

surgery as had acquired sufficient anatomical knowledge. This often led to contentions in which the barbers not infrequently were successful in establishing their independence of medical control or supervision. For this reason the surgeons were for a long time looked down upon as a lower caste by physicians and the public and especially by the military bureaucrats. As late as the time of Frederick the Great the regimental surgeon in the Prussian Army was required to shave the officers, and in the early army of the United States the surgeon was permitted to wear but a single epaulette. The successful appeals of the barber-surgeons of the thirteenth and fourteenth centuries to secure an equal recognition to that granted to physicians is being carried on in the twentieth century by claimants to the right to practice from many of the adherents to various illegal cults which are now being paraded under the high-sounding title of physiotherapy and which claim to be founded in some form or other on all the recent discoveries of chemistry, physics and electricity. It will indeed be strange if some quack does not soon appear and claim to cure all human ills according to the tenets of Einstein's theory of relativity.

Roger and De Mondeville

The most celebrated surgeon of the School of Salernum was Roger, who wrote a surgical text-book describing a method of joining a divided intestine by suturing the ends together over a hollow tube; the use of mercurial ointment in skin eruptions, probably because he had

seen its efficacy in such lesions as were of syphilitic nature, and the use of the ashes of seaweed in goiter. Seaweed is high in iodine content and this was an anticipation of the modern use of iodized table-salt to prevent these swellings of the thyroid gland.

Other surgeons who followed Roger and who were not connected with the School at Salernum deserve brief mention. Theodoric was known for his method of producing anesthesia by the inhalation of soporific drugs. The method probably originated in India centuries earlier, but he gave a description of what was called the anesthetic sponge. This was prepared by immersing and heating a sponge in a watery mixture of the following drugs: opium, hyoscyamus, mulberry juice, lettuce, hemlock, mandragora and ivy. The sponge, after this preparation, was allowed to dry, and when needed was soaked in water and applied to the patient's nostrils. The efficacy rested largely in the opium content, and sleep was produced in the way in which it is obtained in smoking opium.

Henri de Mondeville (1260-1320) stood out against suppuration, or pus formation, as a necessary accompaniment of the healing of wounds, and recommended the checking of hemorrhage by applying ligatures to the bleeding vessels. He was a severe critic of his times, but in spite of his wit, perhaps because of it and of his sarcasm, he made no lasting impression on his contemporaries. It is possible that his failure to impress his colleagues with his pleas for cleanliness in traumatic surgery instead of the prevalent use of ointments was due to his being born before the printing

press was invented. His style can be appreciated from such pithy sayings as "Many more surgeons know how to cause suppuration than to heal a wound," and "God did not exhaust all His creative power in making Galen." His writings remained in manuscript for over six hundred years, and were first printed under the editing of Professor Pagel in Berlin in 1892.

In general during the Middle Ages no personality or intellect developed to enlighten or influence medicine in the way that Hippocrates or Galen had done before or as Harvey or Pasteur were to do later. The story of medicine in this era was influenced by the Church, and by the passive acceptance of the Galenical tradition on the part of the profession. At the time of the triumph of Christianity over paganism the Church was lukewarm to medical study, and although individual bishops took a broader view they were exceptional personalities. With the fall of the Roman Empire of the West and the intermixture of races which followed, intellectual development in all directions came to a standstill except in the matter of theology. In medieval times the Church encouraged the idea that disease was simply a manifestation of the will of God and that relief from it was a matter of seeking God's help in overcoming it. The Church forbade the pagan rites and frowned on the use of charms and other pagan practices, but the Church of the twelfth and earlier centuries can hardly be said to have abolished polytheism or a belief in witches or in magic. Shrines appeared for the worship of saints which took the place of Æsculapian temples, and certain saints came to be associated with the causation and

relief of certain diseases. The bones and relics of some of the saints were supposed to have great power for healing. The names of Saint Guy, Saint Vincent and Saint Vitus were associated with chorea (St. Vitus' dance); Saint Avertin, Saint John and Saint Valentine were connected with epilepsy; Saint Hubert, with hydrophobia. Just as in the Greek temples patients left their crutches behind after they obtained a cure by the worship of Æsculapius, so the Christian shrines accumulated similar testimonials of the efficacy of the worship of the particular saint to which the shrine was dedicated.

The Church came to regard with suspicion any one who endeavored to explain disease on a natural basis or to investigate human anatomy or physiology. The human body was a wonderful handiwork of God, and the Church preferred to let it rest there. Christians looked upon their living bodies with contempt, but since every part was to be resurrected after death, dissection was looked upon with horror. Some opportunity was had for the study of bones during the Crusades, because the crusaders carried with them as part of their equipment large cauldrons in which, in the event of death, their bodies might be boiled and the remaining bones sent home for burial. Because of the attitude of the Church toward scientific investigation medical men of ability and independent thought frequently found themselves in difficulties, and under accusations of heresy. Numerous examples of the hardships of such men are recorded. One is that of Pietro d' Abano, a professor at the University of Padua. Because of an independence

of thought he incurred the enmity of the Dominicans who repeatedly brought charges of heresy against him. For some time he escaped by the intercession of the Pope, was finally brought to trial, but died before the trial was ended. The trial was completed nevertheless; he was found guilty, and his body was disinterred and burned.

Partly as a consequence of this attitude on the part of the Church, the rank and file of the medical profession were of a very poor type and the practitioners were men of little education. As an example of methods in diagnosis of the time may be given a recommendation of the administration of a broth made of leeks, by mouth, to an individual who had been wounded in the abdomen, to determine whether the intestine had been perforated. If under these circumstances the wound smelled of leeks, the diagnosis was evident. Very often the care of the sick was entrusted to traveling physicians who led precarious existences, and who were mostly quacks. In some countries strict laws were enacted to protect the public from these quasi-physicians. The law forbade a physician to bleed a woman in the absence of any of her relations, and in the event of an injury to a person resulting from bleeding by a physician, it prescribed a penalty to be paid by the physician varying in amount with the station of the individual injured. In this law the Visigoths of the Middle Ages adopted the methods of the early Babylonian king, Hammurabi (2000 B.C.). Physicians were held generally in such low esteem by the public that practice was often hazardous even for men of education and ability. People of high station

often caused the imprisonment, or even the death, of a doctor if his patient died.

The influence of the Church on medicine in other ways was good. Religion was founded upon principles of charity, and the early Christians astonished the Romans at the time of epidemics of the plague by the way in which they remained to face the contagion and to nurse their families and their neighbors when others fled leaving the sick to care for themselves. Many of the monastic orders were organized for the care of the sick, and in many communities the sick were cared for exclusively by the neighboring monks. In this way the practice of medicine to a great extent came into the hands of the monasteries where medicine was practiced by a combination of drug remedies and healing by prayer. One of the outstanding figures of monastic medicine was Saint Hildegarde, Abbess of Rupertsberg, whose book, *Physica Sanctae Hildegardis,* contains the description of healing plants, rules for the care of women during pregnancy and afterward, and rules for the suppression of sexual desire. A manuscript of the twelfth and thirteenth centuries is now at Wiesbaden and was printed by John Schottus in 1533 at Argentum.

The Church gradually founded hospitals throughout Europe. These made a great appeal both because of their usefulness to the sick, and the opportunity they gave to the individual Christian to show charity toward his suffering fellows by supporting such institutions. At first these were few in number, but they increased rapidly. Among the earliest of the Church hospitals were the following: one of three hundred beds founded in

Edessa by Saint Ephraim in 375, which came under the control of the Nestorian Christians for a time; the one founded by Saint John, the Almsgiver, at Alexandria in 610; and the Hôtel Dieu founded at Paris about 641 by Saint Landry, Bishop of Paris. By the end of the twelfth century almost all of the European cities and towns of any considerable size possessed one or more hospitals. In the following century these Church hospitals began gradually to be taken over by the municipalities.

One of the most beneficent actions of the Church was the founding of lazar-houses, or hospitals for the care of lepers. Before these were available the leper, once his condition was recognized, became an outcast. Forbidden association with the healthy, he wandered from place to place, concealing his features by a long hood or cloak and ringing a bell to give warning of his approach. Such lazar-houses were built in great numbers throughout Europe. In France there were said to be two thousand of them. In this way compassion was shown upon a class which suffered intensely, and in addition their segregation helped to stamp out the disease.

The Church had an indirect influence on the restoration of Galenical medicine to the Western World by the beginning of the Crusades. These religious wars were ostensibly waged against the Mohammedan rulers who held sovereignty over Jerusalem. At first they were successful, but later they resulted in wars between the Christian rulers which led to the victory of the sultans in Palestine. After the crusaders of the thirteenth century had turned on the Christians of the Eastern

Church, and had looted Constantinople in 1204 A.D. many of its treasures, including books, were brought to western Europe, and when finally the Christian crusaders retreated to their western homes the Sultan Mohammed II captured that city in 1453. Many of the educated inhabitants including physicians migrated to the West and brought with them their manuscripts and other movable evidence of culture. It is probable however that the peaceful invasion by Greek and Arabic culture from Africa and Spain was a more important event in the development of medical thought than that resulting from war and rapine of the Turks and their opponents, the crusading Christians.

V

PARACELSUS

The Revolt against the Galenical Tradition

At the beginning of the sixteenth century Galenism as interpreted by Arabian culture ruled supreme throughout the medical world. All medicine was one profession united with no regard to nationality by a common language—Latin, and an exclusive interest—the study and observation of the human body in health and disease. The art of printing which had existed for half a century had now spread over western Europe. The printed book had multiplied and cheapened the opportunity for learning, and the manuscripts of ancient and more recent authorities in medicine, as of every other branch of intellectual achievement, had been brought to light and presented in printed form to the widened circle of educated men. The medical profession was still controlled by the ideas and ideals of the philosophers rather than by the spirit of investigation of the phenomena of nature which so far as medicine was concerned had influenced so deeply the studies of Hippocrates and of Galen.

Neo-Platonism and the churches both Christian and Mohammedan had won the upper hand over the Peripateticism of Aristotle. The leaders of the medical profession were divided for many years thereafter between those with an artistic and imaginative mind and those

with a materialistic and mathematical urge to investigate and experiment. The Arabian influence had been entirely on the side of the School of Plato, and had introduced much idealist speculation which continued in medical thought for many years thereafter. The ideas of alchemy, with its search for the transmutation of metals and the artificial production of gold, and with its philosopher's stone and a possible elixir of life, came from the vagaries of the dreamers of the East through Arabian culture. The mysticism of the East included a belief in demons and spirits which had an influence on earthly affairs and on human life and death. The Kabbala, or magic, with its world of demons, of ideas and of spirits whose interrelations were controllable by incantations, specific numbers, and catchy words and phrases such as *Open Sesame* and *Abracadabra,* had been injected into medicine from the same source.

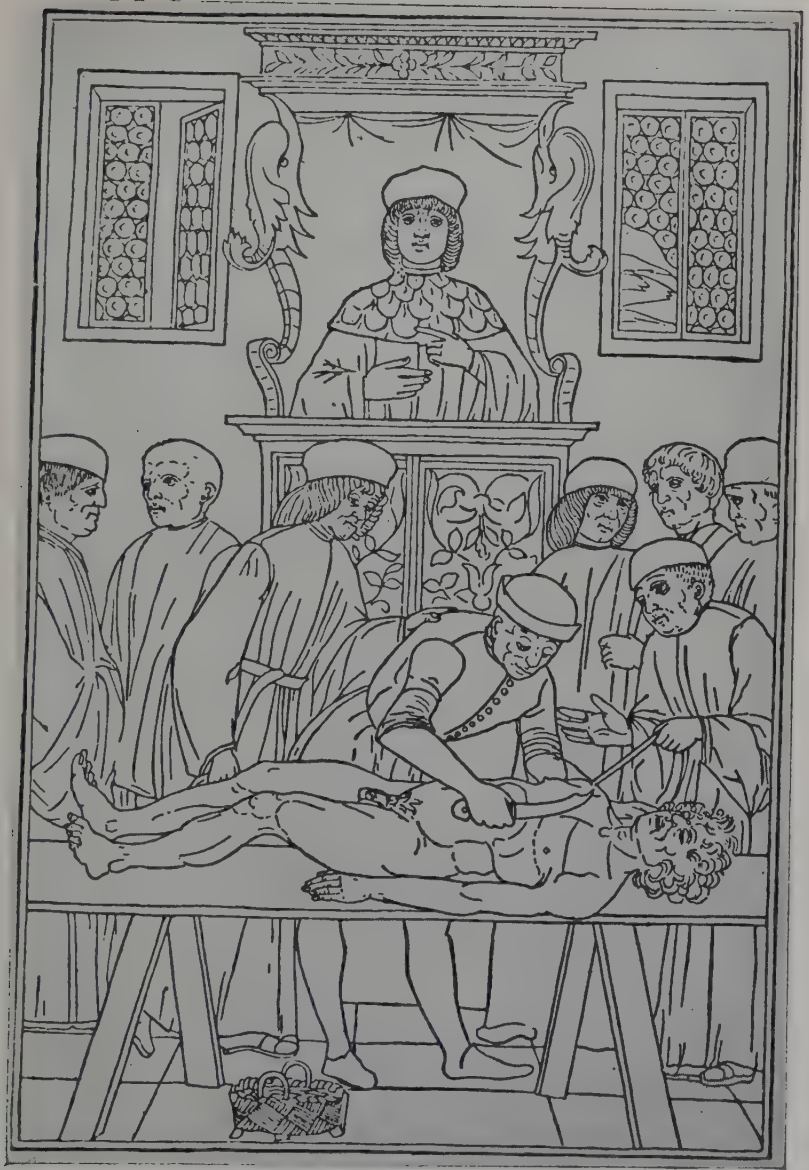
Finally, a belief in the influence of the motions of the stars and planets on the lives of men brought astrology into an every-day relation with the human race, and the casting of one's horoscope at the time of one's birth became as common a rite as baptism. The philosophic dreamers held full sway over medicine; the experimentalist with his observations of nature and his logical conclusions was apparently dead for all time, and medicine was, like the Christian Church of the West, a completed and crystallized philosophy. Galenic medicine was as much a methodic system as ever had been the teachings of Themison against which Galen had been so strongly opposed. This final Galenism lost all memory of the very important additions to knowledge which resulted

from the many experiments in vivisection made by Galen himself, who was sinned against and misrepresented by his ardent supporters of the fourteenth and fifteenth centuries. Such a philosophy led to the active participation in the art of medicine of uneducated charlatans and quacksalvers who became so obnoxious that laws were put in force to control them, and licensure by the local government was required of all physicians in Paris, Naples and other centers.

This Islamic Galen was spread throughout western Europe by the creation of the many universities that existed in 1500. It had its origin particularly in the School of Salernum, and Italian medicine became the leader in this movement but by no means the only active source of medical teaching. In France at Montpellier there had existed a school of medicine since some time in the tenth century but which was not so important a factor in reintroducing the medical culture of the Greeks to western Europe as was the Salernian School. Montpellier, the city, was always in active touch with the Mediterranean, and Montpellier, the School, received Grecian medicine from the Jewish and Arabian physicians early in the course of the invasion of Europe by Mohammedan learning. Montpellier did not become an exclusive admirer of Galen but always paid greater homage to Hippocrates who was adopted as its tutelary lay saint in the words *Olim Cous nunc Monspeliensis Hippocrates.* As time passed the aphorisms of Hippocrates, the systematic teachings of Galen and the therapeutic niceties of the Arabists were taught, and Montpellier became a real rival of Salernum.

The special development of medicine in these two schools was at first surgical, and Roger, as was stated in the last chapter, and other unnamed masters were connected especially with the School at Salernum, while Arnold of Villanova, Henri de Mondeville, and Guy de Chauliac were representative of the School at Montpellier. From the twelfth to the fifteenth century many universities were founded. Some of these had earlier courses, especially in medicine; and the recognition of the later schools, such as Bologna, Paris and Oxford, was followed by new additions founded by the activities both of princes, kings and emperors, and also of the more intellectual of the popes. Italy in 1500 had the largest number of universities. The universities of Seville and Cordova, in Spain, continued foundations begun by the Moors, and Prague, Vienna, Heidelberg, Würzburg, Leipzig, Basel, Budapest, Copenhagen, Upsala in Sweden, St. Andrew's, Glasgow and Aberdeen in Scotland, and many others were all founded before the sixteenth century. Medicine was taught at all of them, and students from every country acquired the habit of going from university to university, no matter where situated, to secure advantages of study from some master mind who enjoyed an extended reputation.

The instruction of physicians at this period required about two and a half years of study before they became licensed to practice. After being licensed they could acquire the additional degree of Master of Medicine by a further six months' study. Students were classified first as clerks, then as bachelors. The bachelors, while under the control of the Faculty of Medicine at Paris, as



From Ketcham's Edition of MUNDINUS published in 1494, in the Collection of The New York Academy of Medicine

Figure V

ANATOMY LECTURE

was typical of all the schools, were permitted to read only such books as were endorsed by the faculty. They were enjoined to regard as a privileged secret whatever they learned. They were forbidden to marry, and were compelled to show at all times a great respect for their teachers. Their course in medicine included the aphorisms and prognostics of Hippocrates and also his book on acute disease, the work of Galen as presented by Arabian authors, the book on the pulse by Philaretus, and the text on pleurisy, fevers and special diets by Rhazes and Avicenna. Anatomy was taught from the dissection of the human body only in Italy, at Bologna by Mundinus, and at other Italian schools. A typical lecture on Anatomy is displayed in the Anathomia of Mundinus as edited by Ketham and printed in 1494. It shows the professor reading from his own writings or from some earlier author, *ex cathedra,* while a prosector demonstrates the anatomical findings on a body laid out on a table below the reading desk of the master teacher. (Figure 5.)

The first and greatest blow to the satisfied state of mind of medicine and Church which characterized the fifteenth century came to the Church. In 1517 Martin Luther, a German monk of no ecclesiastical standing among the dignitaries of the Church, nailed to the door of the Castle Church of all Saints at Wittenberg his famous protest against the errors of administration and venality of the clergy both high and low. The attack on Galenic medicine was less spectacular but equally prolonged and persistent; it began openly in the general denials of everything in the writings of Galen made by

Giovanni Argenterio who had no new theories or recent discoveries to offer but whose plea was for a return to the teaching of the School of Cos. Argenterio tried to start the same campaign that began with Galen himself in the plea "Back to Hippocrates."

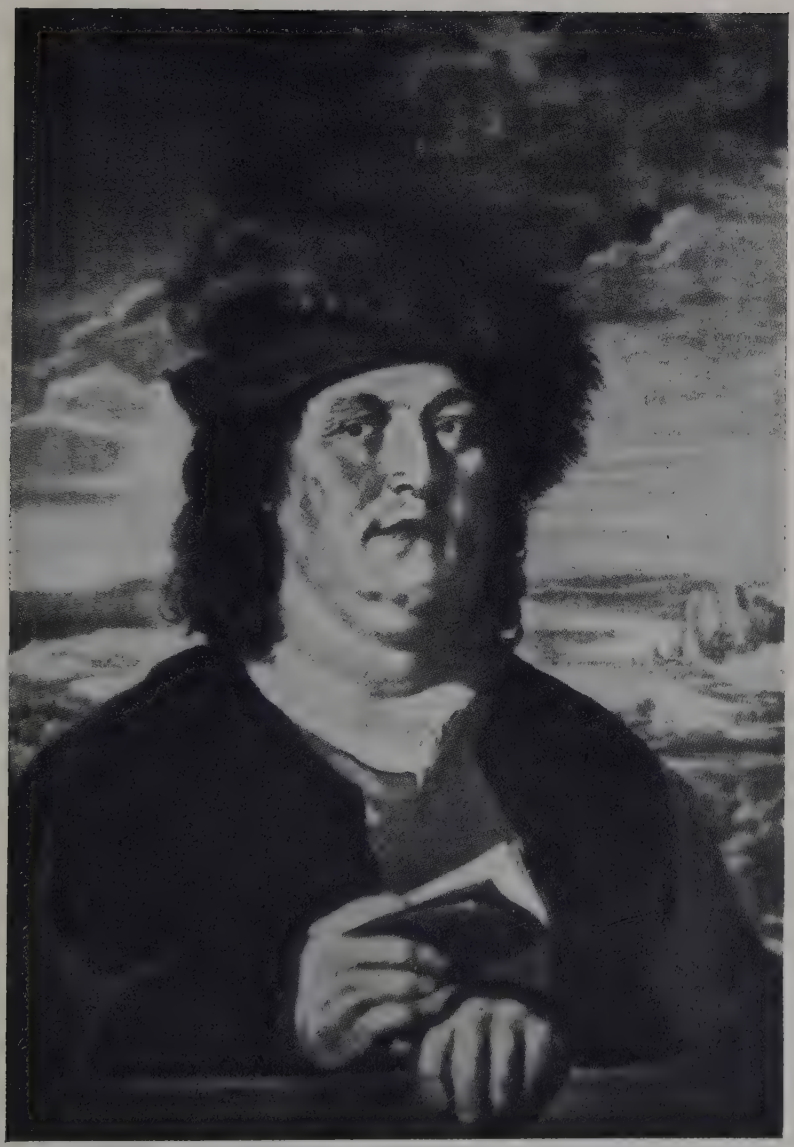
The early sixteenth century produced five great books in medicine. The first complete edition of the works of Hippocrates was edited and translated into Latin by Anutius Foësius a native of Mayence (1528-1591). He studied in Paris, and his Hippocrates in Latin is still the best presentation of the Master of Cos. The second important books to appear were the first Institutes of Medicine. One printed in 1540 by Leonhard Fuchs (1501-1566) was inferior to the book of the same general content, finally called *Universa Medicina* which was published in 1544 by Jean Fernel (1497-1558), who was born and studied in Paris at the Faculty of Medicine. Both these authors were inspired by Galen, but Fernel must be classed as an opponent at least to the accepted infallibility of that author. Fernel denies the theories of Galen as to the causes of disease, and assumes a predisposition in the individual to any disease before the disease in question can develop. He claimed also that specific remedies act on the constitution of the individual and not on the disease. Fracastorius, who was born and died at Florence (1483-1553), is the third authority to oppose the Galenic control of medical thought. He published his book on contagion in 1526, and his poem on syphilis in 1530. He considered the means of contagion to be invisible seeds of disease, *seminaria contagionum,* and anticipated the modern

theories of bacteriology by three hundred and fifty years. Jerome Cardan, another Italian, was born in Milan in 1501, practiced in Paris, Bologna and Bern, and died in 1576. He opposed Galen in every particular. He denied the theory of four humors and left only two—earth and water acted on by celestial heat. He brought every animate object under control of the stars by mystic numbers, and denied the general principle of *contraria contrariis curantur*. He began his academic career as a teacher of mathematics. These opponents of the authority of Galen conceived disease as a distinct entity caused by a fifth spirit in nature, a true seed or some disease-causing vapor.

Paracelsus

The revolt against the established traditions of Galenic medicine culminated in the personality of a most unique character and man of unusual intellect known generally as Paracelsus. He has been called the medical Luther. Philippus Aureolus Theophrastus Bombastus von Hohenheim, called Paracelsus, was a Swiss, born at Einsiedeln in 1493. His father, a member of a noble family, was a learned physician and alchemist from whom he gained his first instruction in medicine. After obtaining his medical degree he traveled throughout Europe accumulating a wide fund of knowledge in medical folk-lore, and in a wide range of subjects, particularly in astronomy and alchemy. In the latter subject he received instruction from Sigismund Függer, a Tyrolean alchemist and mine owner. Paracelsus was always thor-

oughly unorthodox in his mental attitude and a thoroughly original thinker. He rebelled at the influence which the ancients exercised over the profession, and while he showed respect for Hippocrates, he spoke contemptuously of the Arab physicians and of Galen. He seemed to see very little that was good in them and what was more, doubted the veracity of the latter. Inspired by one of his lectures, his students at Basel burned the works of Galen in the market-place. To the medical profession as a whole, whose medical knowledge had its very foundation in the Galenic teachings, this was no less a crime than *lèse majesté*. Furthermore he delivered his lectures in his own tongue, German, rather than in Latin, the universal language of the profession at the time. Paracelsus held his contemporaries in the same low esteem as he held his predecessors, and never hesitated to say so. He referred to his colleagues as "whited sepulchres." In reply to their attacks and to their assertions that he led their patients astray, he told them that they were unworthy "to unloosen the latchets of his shoes." While a physician of such dynamic personality and such unbounded self-confidence was bound to have a large following among the laity, he was also certain to create a great deal of enmity. As the result of the antagonism he created he was forced to resign his position as city physician at Basel where he had been professor of medicine for two years. From Basel he fled to St. Gall where he published three of his books. For these books he selected somewhat bombastic titles: *The Surprising Marvel; Grain of Superior Quality;* and *Transcendental*



From a photograph of a portrait by J. J. Rubens in Brussels, in the Collection of The New York Academy of Medicine

Figure VI

PARACELSUS

Science. The portrait of Paracelsus which is reproduced in Figure 6 from a painting by Rubens shows an overdressed, clean-shaven, self-satisfied-looking individual who is overdoing the prevailing styles for physicians, even in an age noted for the extravagant and bizarre habits of his contemporaries. His appearance belies the quality of his written word and may in part be ascribed to the well-known love of color and elaborate costumes of the artist Rubens.

True medicine, Paracelsus asserted, rested upon four pillars: philosophy, astronomy, alchemy and the virtue of the physician. He conceived philosophy as embracing all the sciences and not as limited to the teachings of Aristotle for which he had little use. Philosophy in his mind embraced anatomy, and his idea of anatomical knowledge was altogether different from that of others. The ordinary anatomical knowledge as obtained by dissection he said was of little practical value and should be left to Italian jugglers. True anatomy, he said, was the anatomy of the essences or the study of the composition of the body which was composed fundamentally of the three substances, salt, sulphur and mercury. He believed also that no one could be a good physician without a knowledge of astronomy because certain stars caused diseases by their exhalations. It was difficult to cure certain diseases while certain stars were in their ascendency. Alchemy was most important in discovering the quintessences of drugs—the substances contained in a drug which actually produced that drug's effect. Only virtuous individuals made good physicians and succeeded in mastering medical problems. He

averred that he himself possessed this virtue to a remarkable degree.

Discarding the Hippocratic theory of the four humors in the causation of disease, Paracelsus devised the theory of the *entia*. The *entia* represented five different agencies which acted to produce disease. These were cosmic influences from the stars *(ens astrorum)*, pathologic poisons as autointoxication from food *(ens veneni)*, natural causes resulting from organic defects *(ens naturale)*, psychic causes from spirits and demons *(ens spirituali)* and causes of divine origin *(ens deale)*. These various agencies induced disease not by causing a disturbance in the harmony of the four humors, but by causing a disturbance in the relation of what he considered the three important elements of the body: salt, mercury and sulphur. Paracelsus was essentially a chemist, and replaced the humoral pathology of Hippocrates and Galen with a new chemical theory of health and disease. Digestion was considered by Paracelsus as a chemical process which separated the nutritive part of the food from that which was not inert but actually harmful. If the latter was not removed from the body it might in itself become a poison and cause disease. He likened the three elements of the body to the results obtained from the distillation of wine. The first result he called mercury, the spiritual eau-de-vie; the thick concentrated liquid remaining after the removal of the "mercury" he designates as sulphur; and the final result of further incineration, the ash, he refers to under the name of salt. He does not deny entirely the importance of the humors of the body but believes that they act

entirely by their qualities and not as themselves.

Paracelsus was the first to draw attention to the fact that individuals in certain occupations were susceptible to certain diseases—occupational diseases. He described particularly a lung condition resulting in miners from the inhalation of dust. As Galen had done before him, he recognized the diathesis in which is associated an affection of the joints and a tendency to the formation of stones in the bladder. In explanation of this he said that the stomach acted to destroy poisons, and other organs to excrete those not destroyed. If a poison failed of destruction or excretion it was deposited on the teeth, in the joints and as concretions in the bladder. He referred to this deposit as tartar because of its resemblance to the deposits in wine casks.

In his treatment of disease Paracelsus combined mysticism with a very practical idea of the uses of drugs. As an example of his mysticism his famous weapon salve may be described. This was composed of the moss grown on a skull exposed to the weather, human blood and human fat, a drug called *mumia* (dried Egyptian mummy), armeniac, oil of roses and linseed oil. The composition of this ointment is remarkable enough in itself, but its method of application is more remarkable still. In case of injury, the weapon causing the injury, or, if this was not to be obtained, a splinter of wood dipped in the blood of the wound was anointed with the salve. Nothing was applied to the wound itself but a dressing of clean lint. Presumably the rationale of this method was that the ointment induced some magnetic-like action on the part of the weapon to withdraw the

poison from the wound. It would seem that this procedure would tax the credulity of even a benighted sixteenth-century mind, but weapon salve was much used.

Paracelsus did not adopt Galen's method of treating opposites with opposites, but insisted that the remedy for a disease was one that corresponded to the organ affected and therefore by supporting that organ would overcome the disease. He discovered these correspondences by the doctrine of signatures. This was rather an involved method. In heart disease he did not advocate, for example, the administration of animal heart but found some plant or substance which he considered had the qualities corresponding to those of the heart. These correspondences were determined by comparing the qualities of size, shape and color. The leaf of the cyclamen, for example, had the shape of a human ear, therefore extracts of it dropped in the ear would cure ear disease. He substituted for the *contraria contrariis curantur* his own *similia similibus curantur* which later became the bone of contention in the great medical schism in American medicine of the early nineteenth century. Paracelsus followed the teaching of his contemporary, Fracastorius, and considered disease something outside of the healthy body, advised a return to the methods of Hippocrates, the observation of disease processes, and an abstention from meddling with the natural course of disease tending to a spontaneous cure. At the same time he emphasized a great principle of modern therapeutics: that the patient should be sustained to renew his vitality so that he can overcome and survive the course of the disease.

His knowledge and interest in alchemy led Paracelsus

to the introduction of several new drugs or drugs hitherto little used. These were mercury, lead, sulphur, iron, arsenic and copper sulphate. He had a great preference for the alcoholic extracts (tinctures), and these have been a favorite preparation for the administration of drugs ever since. Paracelsus was the first to point out that vegetable drugs act by virtue of a contained substance or active principle, and in his writings spoke of these active principles as quintessences. He did not consider that drugs worked by direct action on the tissues but in some mystic spiritual way. Paracelsus had very little respect for the surgery of his time and probably quite rightly so far as surgery was practiced generally. To his credit it should be said that he stood out stoutly against the theory that pus was necessary to the healing of wounds. Paracelsus stated that a physician must be alchemist, theosophist and magician.

From the above description of him it may seem strange that Paracelsus is not classed among the quacks. He must however be judged in the light of the knowledge of his time. He appeared at a time when Europe was emerging from a long period of intellectual darkness and sterility. The most abhorrent crime was heresy. Many others had felt the heavy hand of clerical persecution for expressing themselves too freely on scientific or philosophical matters. Paracelsus never lacked the courage to express what was in his mind. Perhaps his only lasting contribution to medicine was his introduction of certain new drugs taken from the mineral group, but he did medicine a real service in helping to overthrow its thoughtless subservience to ancient authority, and to assert its independence of cleri-

cal restriction. Three hundred years after his death a monument was erected to his memory at Basel, the city from which he was driven in the early part of his career. Paracelsus represented the most extreme example of the contrast to be found in the personality of the physician of his time. His tendency to the vagaries of alchemy and astrology were associated with a brilliant imagination which helped to advance the science of medicine.

François Rabelais

Another iconoclast of the early sixteenth century, François Rabelais, was a contemporary of Paracelsus who did much by his wit and satire to bring the profession back to a rational and scientific study. Rabelais was a Franciscan and later a Benedictine monk who escaped from the monastery to study medicine, and graduated at Montpellier. He was a native of Chinon in Touraine (1494-1553). He published his translation of the aphorisms of Hippocrates directly from the Greek into Latin at Lyons in 1532, and lectured on anatomy at his own university. He is most celebrated however for his satirical writing on Gargantua and Pantagruel. In formulating a prognostication for his hero, Pantagruel, he claimed that he had turned over all the archives of the heavens, calculated the quadrants of the moon, hacked out all that had ever been thought of by all the "Astrophils, Hypernephilists, Anemophylakes, Uranopets, and Ombrophori." It was François Rabelais who said that the practice of medicine was a farce played by three actors: physician, patient and disease.

VI

VESALIUS AND PARÉ

The Revival of Scientific Investigation and Experiment

The criticisms and opposition to the established medical cult of Galen at the end of the fifteenth and the beginning of the sixteenth centuries were based largely on attacks against the theories of medicine which he promulgated and endorsed. Very little change was suggested for the better treatment of the sick. The first real breakdown in the Galenical tradition came from the introduction of dissection of the human body and the discoveries in anatomy which resulted.

Mundinus

The first book to be published presenting new ideas of the structure of the body came from Mundinus who was born about 1275 at Bologna, and taught as professor in his native city. His *Anathomia* was the current text-book for two hundred years. Numerous manuscripts are in existence, many of which consist simply of text without illustrations. It was printed at Bonn in 1478 and was reprinted with the addition of woodcuts at Venice in 1494. Mundinus is important in the history of medicine not because he added anything to anatomical knowledge but because he reintroduced dissection of the dead which had been neglected entirely since the

days of the Alexandrian School in the third century B.C. If Mundinus discovered any new facts he was so overpowered by the ruling authority of Galen that he did not, at least in his book, dare to present them. Practical anatomy from dissection of the body was not general for many years afterward but was always more extensively practiced in Italy than in any other country.

The immediate followers of Mundinus edited his book and incorporated their own ideas but only a few new discoveries, which was far simpler than to present an entirely new description of the human body in accordance with their own observations. It would seem that these early anatomists considered any deviation from the teaching of Galen which might be found, an exception and not the rule, or else they were so imbued with the teachings of Galen that they described what he had described rather than what they really saw. Such an observer was John Ketham, a German, who lived at Venice, and who printed an edition of Mundinus in 1492. The illustrations are inaccurate and roughly drawn but show that the artist had seen the structures which he portrayed. Ketham's book, *Fasciculus Medicinæ,* was republished in several editions between 1492 and 1513.

Berengarius

Jacobus Berengarius, commonly known as Berengar, who was born in 1470 at Carpi near Milan, and occupied the professorship at Bologna, published a more complete edition of the anatomy of Mundinus and added considerable new material, the result of his own dissec-

tions. He was the first positively to deny one of the great errors of Galen and to show that the blood could not pass from one ventricle to the other through the cardiac septum. He published two books, *Commentaria cum amplissimis additionibus super anathomiam Mundini* at Bonn in 1521, and *Isagogæ breves in anatomiam corporis humani* also at Bonn in 1514. His books contained woodcuts of the muscles, of the veins used for venesection and of many parts of the skeleton. Berengar's books although labeled "Human Anatomy" contained much else that had to do with the practice of medicine and especially of surgery. An analysis of his *Isagogæ* was made by the late Professor Huntington of Columbia and showed Berengar to possess a keen sense of humor. He describes a great many details concerning medical education and the life of medical students of his day, and his wit is often on a par with that of Rabelais. Many of his anatomical descriptions are more accurate from the standpoint of our modern knowledge than can be inferred from a cursory examination of the illustrations which are few in number and were drawn by some tyro in art, perhaps by Berengar himself.

Artists as Anatomists

Dissection of the human body in Italy was not confined to a few medical schools and to physicians. The early sixteenth century saw the highest development of painting and engraving both on wood and copper. The painters Leonardo da Vinci, Marc Antonio, Michel-

angelo, Raphael and Titian in Italy, and Albrecht Dürer in Germany, flourished during this period. Leonardo da Vinci left behind him many anatomical drawings which present an accurate picture of dissections of muscles and of the internal organs in many respects superior to the later publications of Vesalius and other medical anatomists. These drawings of Leonardo were stored for many years in the library at Windsor, and were not published in full until the twentieth century although William Hunter mentioned them in 1784, and a partial edition was published about 1866. Other artists had undoubtedly the same training, and although they did not leave so complete a record behind them, anatomical drawings both by Raphael and Michelangelo are in existence. Albrecht Dürer, however, wrote a treatise on the anatomy of form which was published after his death in 1532, and was reprinted within a short period of time in three editions.

Outside of Italy the teaching of anatomy was carried on in all the schools on the basis of the writings of Galen. Jacobus Sylvius was professor at Paris and became celebrated for his brilliant lectures on anatomy, which, however, did not go beyond the teaching of inherited medicine. Many celebrated investigators began their anatomical studies in his lecture-room. Vesalius, Servetus and Charles Etienne were among the number. The securing of bodies for dissection was a very difficult problem for the aspiring investigators of anatomy in the sixteenth century. Although Emperor Frederick II had permitted dissections to go on at Salernum it is doubtful if this was turned to practical advantage by

the faculty and school for no record is found of any practical result following such activities. Owing to the earlier demands for anatomical knowledge of the painters and engravers it was easier to secure bodies in Italy than in any other part of Europe. The robbing of graves to secure anatomical material began about this time. The bodies of executed criminals were supplied in part by the State, but many schools had to be content with from one to four bodies a year. Berengar between the years 1502 and 1527, when professor at Batavia and Bologna, is reported to have dissected more than one hundred. The journey to Italy therefore became a part of every young physician's education.

Andreas Vesalius

A crushing blow to Galenical tradition in anatomy was delivered by Andreas Vesalius. Vesalius was born at Brussels in 1514, of German parentage and of a family of physicians. His first education began at Louvain. At eighteen years of age he studied medicine at Montpellier, and afterward at Paris, and came under the instruction of Sylvius, Günther of Andernach and Vidus Vidius. The teaching was of the usual character. The professor would read from a large volume of Arabian or Galenic medicine while a dissector would do the practical work upon the human cadaver. It was customary for teachers to pay attention to the organs of the abdomen and chest, and to the brain, and omit any particular demonstration of the muscles, joints and skeleton. On leaving Paris, Vesalius returned to Louvain and began

lecturing on anatomy, which post he left to become a military surgeon in the army of Charles V. At the age of twenty-three he accepted a professorship of anatomy at Padua which was then under the control of Venice. Although established at Padua during the next seven years he frequently lectured at Bologna and at Pisa, in which universities he extended the course of anatomy from one of four days to one of seven weeks, and if one may believe the frontispiece of his great work, demonstrated by his own hand, not only the organs of the body but the muscles, joints and bones, nerves and blood-vessels. Vesalius has left two portraits of himself in his great work on anatomy. Both the separate print and the frontispiece of the *Fabrica* show him with a heavy full beard at the age of twenty-nine. The portrait is from an engraving by Medland (Figure 7), and the reproduction of the frontispiece is from the second edition dated 1555. (Figure 8.)

His treatise on anatomy, *De Corporis Humani Fabrica Libri Septem,* consists of a large volume of six hundred and ninety pages illustrated by numerous woodcuts which were drawn for him by John Stephen de Calcar, a pupil of Titian. This work appeared in June, 1543. It had been preceded the previous year by a larger epitome containing seven anatomical plates which served largely as an announcement of the treatise that was to follow. The epitome was dedicated to Philip, the son of Charles V, and the larger work to the Emperor himself. Both books were printed at Basel by Johann Oporinus, where Vesalius spent a year overseeing personally the printing and publication of his book.

From an engraving by T. Medland of a portrait by Titian, in Author's Collection

Figure VII

VESALIUS

The second edition appeared in 1555 and was also printed at Basel by the same printer. The main illustrations are the same, but the frontispiece and the initial letters have been reengraved.

The *Anatomy* of Vesalius presents a new departure in the making of medical books. It is well printed and the illustrations are of a distinctly artistic character. The skeleton and dissections of the muscles are presented in detail but also as a portrayal of the whole body. These drawings represent a man always standing in the foreground with a background representing a landscape including trees and buildings and distant hills. If one looks at the landscape it is found that a series of twelve illustrations can be pieced together to make a continuous panorama, one plate following after another, as if engraved upon one wood-block and subsequently separated. The division of the plates is such that trees and buildings are cut in two, the only object of the artist being to center the anatomical presentation of a human body in its various stages of dissection. It would seem as if the author and artist were planning to be able to claim that the drawings were artistic and not anatomical, for anatomists had previously got into trouble with the authorities by their zeal in adding to their anatomical knowledge by dissection. Charges of heresy were not infrequent against the profession as this time.

The effort to make the book appear a work of art is emphasized in the *Epitome* which contains two full-page drawings of the undissected human body which are usually referred to as Adam and Eve, and which, tradition states, are from the pencil not of Calcar but of

his great teacher, Titian. The initial letters present a most interesting study. Grouped around the various letters of the alphabet are figures of children performing various acts associated either with the study of anatomy or the general practice of medicine. In one initial, these juvenile figures are represented as doing a venesection, in another, as attending a woman in childbirth, in a third these same children are doing a trephining operation on the head of a man. Animal experimentation is depicted by the operation of Cæsarean section on a dog. Many of these initials show the methods of securing and caring for anatomical material. The children are at times removing a cadaver from a gallows, at another time they are robbing a grave. At times they are preparing a skeleton for mounting.

The *Fabrica* of Vesalius is by no means limited to anatomical demonstrations but has to do with surgery and medicine in its various phases. When he wishes to describe the treatment of fractures of the leg he incorporates in the middle of his text as illustrative demonstrations two of his initial letters in which such treatment is shown. Vesalius at the end of his book has a chapter on vivisection. The victim is a pig restrained quite in the modern manner to a dissecting board, but of course without the modern help and relief to the animal rendered by the anesthetics of the laboratories of today. Vesalius in spite of his great addition to anatomical knowledge failed absolutely to understand or grasp any idea of the circulation of the blood. It is an interesting fact that another physician, Copernicus, published his epoch-making book establishing the rota-

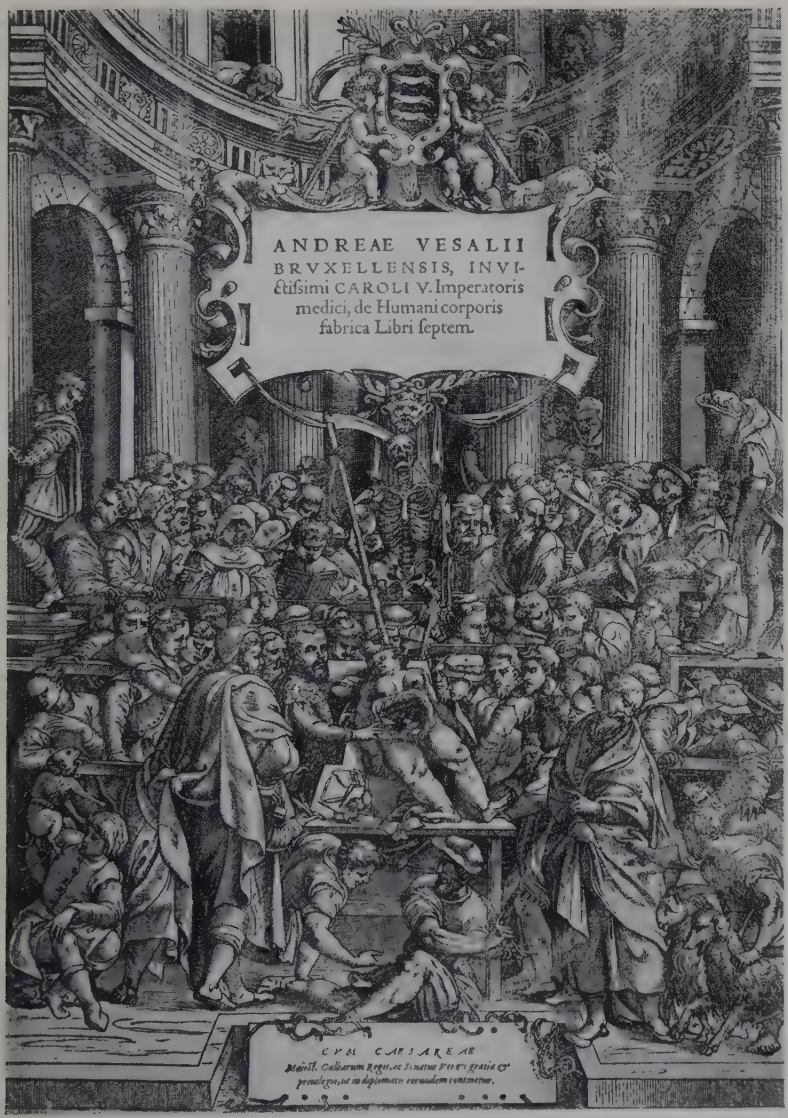
tion of the planets around the sun in the same year, 1543.

The publication of this book met with more abuse than praise. His old teacher, Sylvius, in Paris backed up by Eustachius, professor at Rome who had added new facts to the anatomy of the ear, and Dryander, professor at Marburg, refused to accept any of his discoveries and even went so far as to claim that the body of man in the sixteenth century must be constructed differently from that of the second century if Vesalius had the slightest chance of being right in his claims. Vesalius treated his old master kindly and attacked his younger opponent with vigor. In spite of these attacks on his work Vesalius became famous. The opposition to him and his book so disgusted Vesalius that when he left Padua finally he burned all his note-books, his proposed book on Rhazes which he had edited and also his copies of the books of Galen which he had used as a student. His earlier work with the army of the emperor may also have had some influence, but at all events he left his academic work and professorship and moved to Spain as the personal physician of Charles V, and rose to enjoy the highest honors at Court. After the death of Charles he became attached to the Court of Philip, and royal favor unquestionably became necessary to keep him from the criticisms and attacks of the Church and Spanish Inquisition. Finally he was accused of having opened the body of a patient to determine the cause of death while the heart was still beating. He was saved from torture by royal favor upon condition that he would make a pilgrimage to Jerusalem for his sins. This he did, and on returning was shipwrecked on the

island of Corfu and died, after reaching shore, from the exposure of that accident, at the age of fifty. He was returning to resume anatomical labors at the University of Padua to which he had been recalled because of the death of Fallopius.

The professorship at Padua was filled after his departure by the appointment at first of Columbus, who was prosector for Vesalius, and later of Gabrielle Fallopius, who had previously been at Pisa and Ferrara. Fallopius (1523-1562) was a staunch supporter of Vesalius, who made independent discoveries in anatomy, and remained at Padua until his death in 1562. The next incumbent of this professorship was Hieronymus Fabricius who was born at Aquapendente in 1537. Fabricius served as professor from 1565 until his death in 1619, and was the teacher of William Harvey, the discoverer of the circulation of the blood, during his sojourn at Padua. Julius Casserius (1561-1616) was professor of anatomy at Padua coincidently with part of the service of Fabricius; he published his *Nova Anatomia* with illustrations engraved on copper at Frankfort in 1612.

Vesalius placed Italian medicine, and especially the School at Padua, in the first rank. Young medical men were attracted there to complete their education, later to return home and spread the revolt against the Galenical tradition, for the successors of Vesalius at Padua remained faithful to the memory of the greatest anatomist. Volcher Koyter (1534-1600), a Hollander, was prosector to Fallopius during his stay at Padua and after his return north, published at Bonn in 1566 a



In Author's Collection

Figure VIII

FRONTISPIECE OF FABRICA OF VESALIUS FROM THE SECOND EDITION PUBLISHED IN 1555

description of the bones and cartilages without illustrations. Felix Platter (1536-1614), a German, became professor at Basel and published an anatomical treatise at Basel in 1583, illustrated by excellent copies of the Vesalian plates. Juan Valverde, a Spaniard, studied at Padua and Rome under Columbus and Eustachius and issued at Rome in 1556 a handbook on anatomy also with copies of the illustrations from the *Fabrica* of Vesalius. During his active days at Padua, Vesalius became acquainted with John Keyes, of Norwich, England, for whom Caius College at Cambridge, England, was named and who was physician to Queens Mary and Elizabeth, and served as president of the College of Physicians in London. Caius edited the works of Galen, Montanus and Celsus.

The influence of Vesalius on anatomical illustrations continued for many years. In 1685 Gottfried Bidloo, of Amsterdam, published his *Anatomia corporis humani,* illustrated by plates on the lines of those of Vesalius. These were reengraved on copper by the artist, Gerard Lairesse, and are done more artistically than with reference to accuracy of anatomical detail. The Bidloo plates were used by William Cowper, of London, in his *Anatomy of Human Bodies,* published at Oxford in 1698, which fact caused a bitter controversy. The original opposition to the book of Vesalius brought up the question of the dissection of the human body, and in 1556 the Emperor Charles V referred the matter to the theological faculty at Salamanca and asked for a ruling as to the orthodoxy of the practice. It was decided by those representatives of the Church that anatomical dis-

section by physicians for the benefit and teaching of medicine was permissible. It was many years, however, before anatomical investigation became at all general. In fact there is still a wide-spread opposition to the examination of the bodies of the dead to determine the exact cause of death, and the advance of medicine is hampered to-day by that prejudice.

Ambroise Paré

The relation between anatomy and surgery has always been intimate, and the improved knowledge of anatomy brought about by Vesalius and his followers could have no effect other than to improve the operative technique of the surgeons. Owing to the universal ignorance as to the cause of infections and the tendency of the surgeons always to refer bad results to the wound and not to the treatment given, the effect of the new anatomy was not immediately apparent. The surgery of the sixteenth century was advanced by the activities of the great Frenchman, Ambroise Paré, who was born at Laval in 1510. The story of his life is that of a man rising from humble beginnings to great celebrity in his art. He is believed to have been the son of a barber. As a boy he served the hard life of a barber's apprentice and had little or no opportunity to educate himself. He went to Paris and followed his trade there until he was admitted as a barber dresser to the Hôtel Dieu. Here he lived for three years, dressing wounds and assisting the surgeons and barber-surgeons. He was keenly interested in his work, made use of every opportunity

to improve himself both by contact with and observation of other surgeons, and by anatomical dissection, and showed himself self-reliant and original. Upon leaving the Hôtel Dieu he began his career as a military surgeon. He spent the remainder of a long life partly in military service with the French armies and partly in private practice in Paris. Recognizing the disadvantages under which he labored with a rank no higher than that of barber, he managed to take a course in preparation for the profession of master barber-surgeon. He was finally qualified as such by the Medical Faculty of Paris.

As has been said, Paré had little opportunity for education in his youth, and later in life he was forced to hire others to translate the Greek and Latin texts of medical authors for him. To a man of Paré's type this was in a sense an advantage. He was himself possessed of great originality and had great accuracy of observation. He was not fettered by ancient authority in forming his opinions but was in a position to found his knowledge on practical experience rather than on theories which were frequently based on false premises.

Paré's talents were recognized early in his career, and he had the distinction of becoming the private surgeon to four successive French kings. His personality was such that he was welcome with the courtiers, with rough soldiers in the camps and in private practice in the French capital. The story of Paré's life and work is told in his writings which contain descriptions of his journeyings in the various military campaigns, of his professional methods and of his life at Paris. Extracts

of some of these writings have become classic. One famous saying of Paré, and one which he frequently repeated after describing the treatment and cure of a case was, "I dressed him, God cured him."

In the early part of his career Paré tells of an incident in which after a battle he was going about in company with an old soldier caring for the wounded. They entered a barn and found three hopelessly wounded soldiers. His companion asked the young surgeon if anything could be done for these men and when told that each case was hopeless, Paré says the veteran took his sword and cut the neck of each soldier "gently and without ill will toward them." To Paré's remonstrances, the soldier replied that he prayed God that in similar circumstances some one would do the same for him. The portraits of Paré show a spare tall man with a trimmed and pointed beard in the manner of Henry IV of France and of many of his contemporaries. (Figure 9.)

Among Paré's writings is a description of the plague, that terrible epidemic disease which swept over all the earth at intervals during the Middle Ages, and in one epidemic actually reduced the earth's population by one-quarter. He describes the symptoms of the plague, the duties of the authorities in preventing and checking it, the rules for attendants and physicians in treating it and protecting themselves from it. He has written the following description of its effect upon a stricken community: "The country towns, villages and hamlets are all shut up close, even their own homes are shut against the masters of them so that they must camp out in the fields as best they can, away from all human

From an engraving by Dequévanville, in the Collection of The New York Academy of Medicine

Figure IX

PARÉ

intercourse and acquaintances: all of this happened at Lyons on the Rhone, where those patients who camped out in the open country were overpowered by the heat of the day while at night the cold gnawed upon them, and brought with it other fatal diseases. And what is worse, in one of these field-huts there was that sight of a father and mother grievously ill, not able to help their child, and they saw it smothered and bitten by wasps, and the mother to save it got up and fell dead between her child and her husband. Again, he who has vassals, serfs or servants is deserted by them: they turn their backs, and none dare to go to him: even the father abandons his child, and the child, his father: the husband, his wife: and the wife, her husband: the brother, his sister, and sister, her brother: and those whom you think your nearest and truest friends abandon you now in the horror and peril of the disease. And if any man, out of pity and Christian charity, or from kinship, will help and visit the sick man, nor parent nor friend will afterward talk with him or come near him."

One of Paré's first influences on surgery was exerted in bringing about the abandonment of the use of hot oil in the treatment of gunshot wounds. Gunshot wounds at this time were considered more serious than wounds from ordinary weapons because it was thought that bullets entered the body while hot, in this way burning the tissues, and that gunpowder poisoned wounds. For this reason it was the common practice to cauterize such wounds by pouring boiling oil into them. On one occasion Paré's supply of oil gave out and he was compelled, not without trepidation, to dress the wounded

without it. He found, however, that the wounds did much better than those in which the oil had been used and the patients suffered much less. After this Paré was always a strong opponent of the use of oil.

Paré was best known for the improvement he made in the art of amputation. While he was not the first to use ligatures to stop hemorrhage in amputation, he was the first to bring the method forcibly to the attention of the profession. The usual method of his time was to use the cautery to check hemorrhage and to cauterize the bone stump. Paré stopped the cauterization of the bone and by use of forceps of his own invention caught and tied the bleeding vessels with the result that amputation done by his method did much better than did those done by the old methods.

The first exarticulation of a joint was performed by Paré on an elbow. It was done under difficult circumstances on a patient in such poor surroundings that a cowshed provided the only shelter. It was characteristic of Paré that his interest was always in his art and not on expected reward. After performing the operation he had great difficulty in getting the patient nursed, and to add to the difficulties lockjaw developed. Paré did not lose courage but increased his efforts, had the patient placed near the cattle that he might get more warmth, and fed him through a tube by prying his teeth apart. The patient eventually recovered.

Paré's inventive faculties were shown in the invention of new instruments, by his devising of artificial limbs, of trusses for the treatment of hernia, and of artificial eyes. He contributed to obstetrics the method of podalic

version, and in dentistry he pointed out that teeth if knocked out could sometimes be successfully reimplanted.

In his attitude toward the medical preparations in use at his time Paré seems to have shown at times a strange credulity, and at times a shrewd skepticism. He was always on the lookout for remedies which seemed successful in the hands of others, and often paid considerable sums from his own purse to purchase remedies from quacks in order that he might publish the secret for the benefit of the poor. In this way he acquired his celebrated "puppy salve" for which he claimed great merit in the treatment of wounds. This salve was compounded by mixing earthworms prepared with Venetian turpentine, with the bodies of new-born whelps boiled in the oil of lilies. On the other hand the works of Paré contain an essay in which he derides the popular use of the two drugs—dried mummy and unicorn's horn. *Mumia* was a drug of great popularity and was considered the sovereign remedy to be taken internally for the pains of bruises and sprains. The genuine article consisted of the resinous débris of ancient Egyptian mummies. Paré declared that most of it in use was spurious and that a great deal of it was obtained from individuals who made a practice of robbing the gallows of hanged criminals, eviscerating the bodies, drying them in an oven and covering them with pitch. Genuine or not, Paré said, he had never seen it do anything but cause a stomach-ache to those who took it, which, he said, was to be expected since it smelled so badly that fishermen used it as bait! Powder of the horn of the mythical unicorn had a great vogue as an antidote for

poisoning. Paré doubted that such an animal existed and declared that the substance was usually made from the horn of the rhinoceros or even of domestic animals. In any event he said he had tested the usual assertion that if a ring were drawn around a frog or spider with unicorn's horn they would remain within the ring and never cross it, and had found that this was not true.

Paré because of his eminent ability incurred the usual jealousy of other members of the profession of less talent. He was frequently attacked for some of his statements. His was not a nature to be much depressed by such attacks, and to some he replied vigorously; others he ignored. He was always a favorite with the public and much thought of at Court. It is said that he was one of the few Protestants who escaped the massacre of St. Bartholomew's Day. He died in 1590 at the age of eighty, in the enjoyment of a popular admiration and universal esteem.

Wilhelm Fabry

A late contemporary of Ambroise Paré is looked upon as the father of German surgery. Wilhelm Fabry was born at Hilden in the Rhineland in 1560, and died in 1624. A statue commemorating his achievement stands at Düsseldorf. He was well educated by study and reading but not by attendance at a university. A skilful and an able operator, Fabry introduced many new instruments in surgical practice. He was a believer in the simple treatment of wounds and disbelieved in the common practice of his day of applying to them all kinds

of oils and ointments. He was a great student of Galenical writings and opposed to the newer vagaries of Paracelsus. Nevertheless he could not avoid some of the errors of his time and was particularly an advocate of the so-called "weapon ointment," attributed to the invention of Paracelsus.

The weapon ointment was a complicated mixture made of drugs that were difficult to obtain, as already described. Its use had a distinct flavor of magic in it for it was applied not to the wound but to the weapon which caused the wound. It can readily be surmised under present-day ideas of the aseptic treatment of wounds that it was not the presence of the weapon ointment on the weapon but the absence of the ointment from the wound which caused its more rapid healing. Another magical remedy used at this same time was known as "sympathetic powder." This consisted entirely of sulphate of copper which had to be dissolved, filtered and recrystallized two or three times. During the process of preparation the crystals must be exposed to the sun during the months of June, July and August. Such mummeries in the compounding of medicines are to be found throughout the preparation of household remedies in the times of our great-grandfathers. The use of the sympathetic powder was of the same general character as that of the weapon ointment and was applied to the blood-stained clothes of the person who had been wounded. It influenced favorably the healing of a wound, even if the clothes were kept at considerable distance from the patient who was to be treated. Oliver Wendell Holmes can not refrain in describing these

ancient forms of absent treatment from taking a slap at his own pet medical bugbear—homeopathy—when he says: "In fact the unguentum armarium and sympathetic powder resemble more recent prescriptions, the latter consisting of an infinite dilution of the common doses in which remedies are given, and the two former in an infinite dilution of the common distance at which they are applied."

VII

HARVEY

The Discovery of the Circulation of the Blood

Before Harvey the men whose ideas had the greatest influence on the prevailing conception of the physiology of the blood were Erasistratus and Galen. Erasistratus considered that the air was drawn into the left ventricle from the lungs and pumped from it through the arteries to the tissues; that in health the arteries contained only air, and that the veins contained only blood; that there were communications between the fine branches of the arteries and of the veins, and that in abnormal conditions of disease blood escaped from the veins into the arteries. Galen disproved the theory of Erasistratus that the arteries contained air. He considered that the veins originated in the liver; that the arteries originated in the heart; that the liver supplied the blood with nutriment, and that the left ventricle of the heart supplied it with a hypothetical vital spirit just as essential as nutriment. He traced the blood by way of the veins from the liver through the heart to the lungs. But since he admitted that the lungs must have vital spirit as well as nutriment and since he was in ignorance of the pulmonary circulation, he made his theory tenable by stating that there were minute pores by which blood containing vital spirit entered the right from the

left heart. As he said the pores were invisible, it was difficult to prove or disprove his theory.

Another of Galen's fallacies was his contention that the heart influenced the motion of the blood not by its contraction or pumping force but by its dilation or suction. It seemed to be his idea that there was an ebb and flow of blood between the liver and heart on the one hand, and the tissues on the other. The nearest approach to an idea of the circulation of the blood in Galen is found in the description of the route by which a drug given to influence a condition of the lungs would reach that organ upon being sufflated. Galen says for a drug to arrive at the lung it is necessary to take the following course: from the mouth into the pharynx and esophagus to the stomach and small intestines, being absorbed by the veins of the mesentery it is transferred to the veins on the under surface of the liver, then into the vena cava, the right side of the heart, and finally to the lung. There is no word in Galen of any return circulation from the lung to the heart. Describing the nourishment of the general tissues of the body, Galen states that the nourishment must in the same way be supplied by the veins from the liver, and again there is no suspicion of any return flow. To equalize the circulation Galen invented the non-existent pores in the septum of the heart.

Galen knew nothing of the physiological uses of the inspired and expired air, and gave as the only explanation of respiration that it was necessary to cool the blood which would become overheated from the heat generated in the heart itself.

Michael Servetus

The first mention of circulation is the description of the lesser or pulmonary circulation by Michael Servetus who was a Spaniard born at Villanova in 1511. He was a student of theology and of medicine, and had been a fellow student of Vesalius in Paris under Sylvius; but Servetus was a liberal thinker and dabbled in astrology for which he wrote an apology, the only existent copy of which is now in the National Library of France. In 1553 he wrote a book on the restoration of Christianity,—*Christianismi restitutio,*—one copy of which is in the library at Paris, and the second at Venice. In this book he describes accurately the circulation of the blood through the lungs from the right to the left side of the heart. Servetus had been criticized previously for his astrological tendencies, and his final book got him into serious trouble. Under the leadership of John Calvin he, with all his books that could be found, was burned at Geneva as a heretic. The three volumes mentioned above are the only known examples of his two publications which remain extant. His book on the restoration of Christianity with its description of the pulmonary circulation was reprinted in 1790 at Nuremberg, and is also excessively rare.

Matthæus Realdus Columbus

Matthæus Realdus Columbus was born at Cremona in Italy, and studied with Vesalius for whom he acted as prosector. He published in Venice in 1559 a treatise on

anatomy in which he described accurately the pulmonary circulation. He described also the relation of the systole or contraction of the heart to the pulse, but he failed to overcome his inherited notions of the physiology which Galen had fastened upon the world.

Andreas Cesalpinus

Andreas Cesalpinus was born in 1519 and died in 1603. He was a pupil of Columbus and therefore came under the influence of Vesalius. He was an independent observer who was not afraid to describe anatomical facts observed by him even when they varied from the traditional descriptions. He published his book, *Quæstiones Peripateticæ,* at Venice in 1571, in which he followed his teacher and seemed to have a suspicion of the general circulation. Cesalpinus was a student and follower of Aristotle and could not rise above the dictum of that great philosopher that the heart was the site of the production of heat, and of all the activities of life.

Hieronymus Fabricius

Hieronymus Fabricius occupied the chair of anatomy at Padua which had been filled by Vesalius and Fallopius immediately before him. In 1574 Fabricius published a description of the valves of the veins but without paying any particular attention to their significance as a proof that the blood must flow from the periphery to the heart and not in the opposite direction as Galen had taught. Fabricius unquestionably taught this anatomi-

cal fact to his pupil, William Harvey, when the latter studied at Padua.

William Harvey

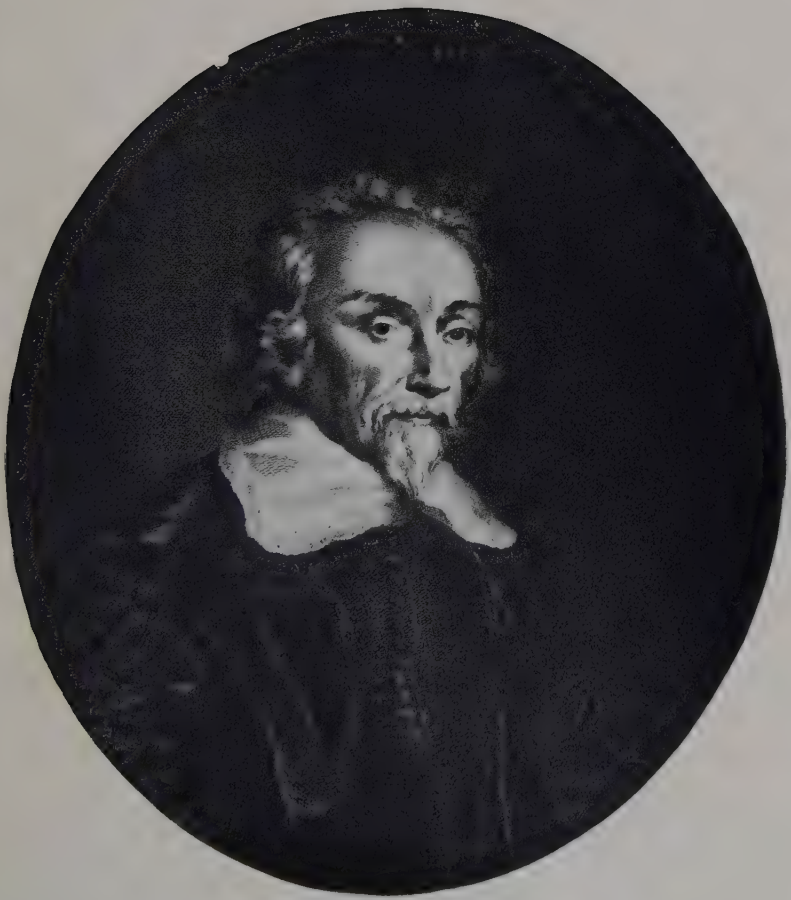
William Harvey was born at Folkestone, Kent, in 1578. His father was a wealthy citizen of Folkestone and for a time mayor of that city. Harvey was the eldest of nine children. His six brothers entered business and became successful men of affairs. William Harvey entered Caius College at Cambridge at sixteen, and graduated with the degree of Bachelor of Arts at nineteen. At this time the universities of northern Italy were at the height of their fame, and Harvey after leaving Cambridge entered the University of Padua, attracted there probably by its famous teacher of anatomy and surgery—Fabricius. Harvey must have made a strong impression at Padua as he was a member of the student council and became a great friend of Fabricius. Upon graduation his diploma stated that "he had surpassed even the great hopes his examiners had held for him." He graduated from Padua in 1602, and returning to England in the same year, he received his medical degree at Cambridge. In 1604 he was licensed to practice medicine by the College of Physicians.

In England at this time the practice of medicine and surgery was under the supervision of two corporate bodies: the College of Physicians and the Barber-Surgeon's Guild. These corporations sponsored lectures on medical and surgical topics, and by legislative enactment each organization was allowed the bodies of four crim-

inals executed in London each year upon which public anatomies were held. These anatomies were conducted according to set rule and with much ceremony. They lasted three days with morning and afternoon sessions and with banquets between each session.

Harvey early obtained office in the College of Physicians. In 1613 he was appointed a censor, as member of a board who supervised the action of medical practitioners and apothecaries in London. Later he held the offices of elect and treasurer. In 1654 he was chosen president but refused the appointment because of his age. Harvey was also appointed physician to St. Bartholomew's Hospital and became the Physician in Ordinary and close friend of King Charles I. In 1615 he was appointed to the Lumleian Lectureship. The Lumleian lectures were founded by Lord Lumley in 1571, and endowed with a sum of forty pounds annually in perpetuity. By the terms of the endowment two lectures a week throughout the year were to be given by a lecturer of note on prescribed topics. Harvey was the fourth to hold this lectureship, and in these lectures he first began to enunciate his doctrines of the circulation.

Harvey, a small man, "easy and graceful of movement," with piercing black eyes and a quick temper, was physician and friend to many men of rank and distinction. There are a number of portraits to choose from in presenting one of William Harvey. That engraved by Houbraken from the painting by Bemmel is quite characteristic and shows him dressed in a simple coat with broad collar and a beard cut in the style of his master patron, Charles I, as portrayed by Van Dyke. (Figure 10.)



From an engraving by Houbraken of a painting by Bemmel in Birch's HEADS OF ILLUSTRIOUS PERSONS, in Author's Collection

Figure X

HARVEY

Aside from his knowledge of his own special field he was generally well informed and an industrious student and observer. He always showed a great toleration and respect for the opinion of others, and in reply to criticism of himself showed great restraint. In 1628 he published his book on the circulation called *De Motu Cordis et Sanguinis*. The book was published in Latin at Frankfort not so much because it would cause less stir if published abroad as that a book-fair in that city in that year offered special facilities for publication.

To-day the average layman knows that the blood circulates in the body, and has a rough understanding of how this is accomplished. He knows, for instance, that the heart acts as a pump; that arteries carry blood from the heart; that the veins carry blood to it; that the heart is divided into right and left chambers which in turn are again subdivided into upper chambers or auricles, and lower chambers or ventricles. He can trace the course of the blood from the left ventricle into the large artery, or aorta, and knows that it is distributed to all parts of the body by branches of this vessel; that these branches become smaller and smaller until they divide into a microscopic network of fine vessels which connect (anastomose) with similar small branches of the venous system. He knows that the blood is collected from the small into larger and larger veins until it reaches the large vein of the abdomen (inferior vena cava), or the large vein in the upper chest (superior vena cava), and that these two veins empty the blood into the upper chamber of the right heart from which it enters the lower part to be pumped to the lungs. Here

it goes through the same division into small vessels, is re-collected and carried back to the upper part of the left heart where it enters the lower part or left ventricle, and thus completes its circulation, and starts again on the same journey. He understands also that while in the lungs the blood takes oxygen from the inspired air and gives off carbon dioxide.

At the time of Harvey very little was known of chemistry, and oxygen and carbon dioxide were unheard of. The blood was considered to have some vital function which was not understood. It was spoken of as containing some activating principle, "a vital spirit," which might be some supernatural agency,—even the soul itself. The fact that it is essential to bodily structures and that the tissues of the body are supplied with oxygen, and give off carbon dioxide in order to support life, was of course an unheard-of conception. From the time of the ancients there had been speculation as to the meaning of and relationship between the two striking bodily functions,—breathing and the beating of the heart. Nor did the discovery of Harvey give final answer to these inquiries.

This brief summary presents the authoritative views on the motion and action of the blood before Harvey. To the present-day mind, that the blood circulates seems as self-evident as the law of gravity; yet Galen, who was an intellectual giant, and many clever men before and after him had striven for an irrefutable explanation of the problem. The views of Galen were so strongly entrenched in the minds of most of the profession that he was considered infallible, and any one who attempted

to controvert his views was subjected to criticism, ridicule and even abuse.

Harvey began to enunciate the doctrine of the circulation of the blood in 1616. He did not publish his views until twelve years later when his book was published at Frankfort in Latin. This delay in the publishing of his doctrine was due to his recognition of the "attachment of man to custom and authority," and his realization of the hostility and criticism which would result from the effort to advance novel opinions at variance with the accepted views. In his introduction he points out the shortcomings of some of the prevailing views on the action and uses of the blood, and speaks of the hesitancy and reluctance he feels in venturing to arouse the inevitable hostility and criticism which must follow the introduction of new ideas. He then proceeds to outline the steps which have led him to his conclusions, supporting them with demonstrations and experiments. The work is written in extraordinarily clear and concise language. The argumentation is impressively logical. Except in a few places, where he uses the physiological terms of the day, the description seems thoroughly modern.

He devoted his early chapters to a description of the motions of the heart. The analysis of the heart's motion seemed to him at first difficult and bewildering because the contractions were too rapid to grasp the whole of what happened in a single cycle. However by recourse to observation of the heart in lower animals, in which the heart beats more slowly, and in observing the slowed and dying hearts of higher animals he was able

to convince himself that there were two motions of the heart occurring consecutively and not synchronously. These are, first, the contraction of both auricles simultaneously, followed by the simultaneous contraction of both ventricles. These contractions are followed in the same manner by dilatation of the auricles, then of the ventricles. Thus blood was poured from the veins into the auricles, was forced from them into the ventricles, and by them into the arteries. Valves between the auricles and ventricles acted as doors which closed and prevented the blood from returning to the auricles when the ventricle contracted. This refuted Galen's contention that the diastole or dilatation of the heart was the active agency in moving the blood. It was obviously an error, Harvey said, to consider, as was the custom, that the arteries and heart contracted at the same time, for accurate observation proved that the arteries dilated when the heart contracted by the force of the blood pumped into them. In other words, the systole (contraction) of the heart was synchronous with dilatation (diastole) of the arteries.

Taking up next the circulation of the lungs, he traces the blood from the right ventricle through the lungs to the left auricle. He points out that animals without lungs, like the fish, are also without the right chambers of the heart—they have only one auricle and one ventricle; furthermore, that in the fetal development of the human embryo before the lungs begin to function the blood is shunted from the right heart to the left by means of a foramen or opening in the septum between the auricles, and also by a blood-vessel between the

artery leading from the right ventricle and that from the left ventricle (the *ductus arteriosus).* When the lungs begin to function, *i.e.,* when respiration begins, these openings close, the short-cut no longer exists and all the blood must go through the lungs. He therefore infers that the quantity of blood going to the lungs is much too great to be required for nutrition alone; for why, he asks, should the lungs have so much more blood for this purpose than such delicate organs as the brain or the eye? The only conclusion one can reach is that *all* the blood is carried to the lungs to receive some activation from the contained air.

He finally advances the most convincing argument in his thesis in a chapter headed: "On the quantity of the blood passing through the heart from the veins to the arteries; and of the circular motion of the blood." He argues thus: "I frequently bethought me and long revolved in my own mind what might be the quantity of blood which might be transmitted, in how short a time it might be effected, and the like. But not finding it possible that this should be supplied by the juices of the ingested aliment without the veins on the one hand becoming drained or the arteries on the other hand becoming ruptured, unless the blood should somehow find the way from the arteries into veins and so return to the right side of the heart, I began to think whether there might not be A MOTION AS IT WERE IN A CIRCLE. Now I afterward found this to be true." He then reduces the situation to a question of mathematics, and says: "Let us assume either arbitrarily or by experiment that the quantity of the blood which the left ventricle of

the heart will contain when distended to be, say two ounces, three ounces, or one ounce and a half,—in the dead body I have found it to contain upwards of two ounces. Let us assume further how much less the heart will hold in the contracted than in the dilated state, and how much blood it will project into the aorta upon each contraction, and all the world allows that with the systole something is always projected,—and let us suppose as approaching the truth that the fourth, or fifth, or sixth, or even but the eighth part of its charge is thrown into the artery at each contraction, this would give either half an ounce, or three drachms, or one drachm of blood as propelled by the heart at each pulse into the aorta, which quantity by reason of the valves at the root of the vessel can by no means return into the ventricle. Now in the course of half an hour the heart will have made more than one thousand beats, in some as many as two, three, or even four thousand. Multiplying the number of drachms by the number of pulses we shall have either one thousand half ounces, or one thousand times three drachms, or a like proportional quantity of blood, according to the amount we assume as propelled with each stroke of the heart, sent from this organ into the artery; a larger quantity in every case than is contained in the whole body." Applying the same mathematics to an animal such as the sheep, and assuming that the ventricle propels but a single scruple at a beat, he says the total would amount to about three and a half pounds injected into the aorta every half-hour, yet he himself has ascertained that the whole body of the animal contains less than four pounds. And so,

since the blood is incessantly poured into the arteries in larger quantity than can be supplied by the food, it must of necessity perform a circuit.

Having shown the necessity for a circulation of the blood, he goes on to show how the circulation is brought about. By experiment with ligatures he shows that the blood in the arteries flows away from and that in the veins flows toward the heart. Observation on himself and others support this. When he applies a tourniquet on an arm tight enough to shut off the artery he notices that the artery above the tourniquet becomes fuller and beats more forcibly than before. With the ligature thus tightly applied the veins collapse. Now if the tourniquet is applied less tightly so that the artery is not shut off, the veins below the ligature become overfull while above it they collapse. By this means the function of the valves of the veins can be demonstrated, and it can be shown that they act to prevent the blood from flowing back or away from the heart. When the tourniquet is applied in the way just mentioned knotty places are noticed along the course of the veins particularly at the places where one vein joins another. If the finger of one hand is placed firmly upon one of these knots or valves and with the finger of the other hand the blood is stripped upward to the knot above, it will be seen that this part of the vein remains empty after the second finger is removed, and furthermore that pressure on the vein above the upper valve does not force the blood back through the valve to the empty strip. Now if the first or lower finger is removed the empty part of the vein fills up.

Harvey knew that the veins and arteries must communicate, but this communication takes place by means of very minute branches of the two systems. These branches are not visible to the naked eye. While Harvey knew this to be so he had not the means to demonstrate it because the microscope was not then in general use. Study of the valves of the heart further confirmed his theory, a study of these valves showing that they allowed the blood to flow in the direction of the circuit but not contrariwise. He found clinical facts also to support his doctrine. He cited that in snake-bites the whole system became quickly affected, showing that the poison must be quickly distributed through the body. He used hydrophobia as another illustration, pointing to the occurrence of general symptoms long after the bite of the rabid dog had healed.

Thus far in dealing purely with the physics or the mechanics of the heart and blood-vessel system Harvey's theme is faultless. He can not in the end, however, escape error resulting from the imperfect knowledge of his time. The use of the blood as a vehicle for oxygen was unknown to him for oxygen was unknown until 1772. He recognized that it fulfilled some important function other than that of carrying nutrition to the tissues. In conjecturing on the further uses he becomes involved in mysticism. Death, he says, is a corruption which takes place through a deficiency of heat. Since all living things are warm and all dead things are cold there must be some seat, fountain or hearth from which this heat is supplied. The heart, he thinks, must be this place. Further, he suggests that the aliment

absorbed from the stomach and intestines may be rendered more suitable for use by the body or perfected by the heart.

In 1661 Malpighi, with the compound microscope which was made of two lenses and had been invented by Johann and Zacharias Jenssen about 1590, demonstrated in the frog's mesentery and lungs the network of fine vessels called capillaries which connect the arteries and veins, thus giving proof of the final necessary link in the circulation.

Just prior to the publication of Harvey's book Gaspar Aselli (1581-1626), of Cremona, was professor at the University of Pavia where he discovered, as he himself says entirely by chance, the chyle-bearing vessels in the mesentery of a dog. This discovery was published at Milan in 1627. Subsequently in 1648 Jean Pecquet (1622-1694) demonstrated the thoracic duct and the lymphatic vessels, which name was given them by the independent discovery in 1651 by Thomas Bartholinus (1616-1680) at Copenhagen. The demonstration of these vessels added materially to the knowledge of the circulation, although William Harvey never admitted their existence, resting his objection on the ground that he had never seen them.

It seems amazing that Harvey's discovery was received with indifference by the majority of his contemporaries. In the writings of Alexander Reed who lectured at the Barber Surgeon's Hall on anatomy while Harvey was lecturing at the College of Physicians, no mention of Harvey's work is made and they contain the old and unsatisfying theories. Many refused to ac-

cept Harvey's doctrine, criticized it, and even subjected it to ridicule. The most active of his critics was Riolanus of France who seems to have spent most of his later years attacking the doctrine. On the other hand the doctrine found support at the hands of many able men.

Harvey spent most of the remaining years of his life devising experiments to confirm the doctrine of the circulation. In his replies to his critics he always exercised patience and tolerance, and showed fine respect for the opinion of others. With the accession of Cromwell, Harvey was forced to flee from London with the king. In his absence his residence was entered by the soldiers of Parliament and many papers containing notes of his researches were destroyed. After the beheading of Charles I he resided and did some work at Oxford, but soon retired to the estate of one of his brothers where he led a quiet life, keeping in touch with scientific matters but avoiding all controversy. At this time he published in 1651 the result of his earlier work on generation. His extraordinary powers of observation as well as his knowledge of animal and bird life are further evidenced in these essays which also indicate the great breadth of his knowledge in addition to his profound understanding of his special field.

Harvey died in 1657 at the age of seventy-nine. He was buried in the family vault at Hempstead, Essex. In 1833 the College of Physicians repaired this vault and had the lead casing of the body placed in a marble sarcophagus.

The work of Harvey was not only great in that which he discovered but also in the thoroughness of his

proof and demonstration. His predecessors discovered some facts by observation or even by experiment and elaborated conclusions or theories from facts when they had them, but did not hesitate when the facts were missing to incorporate in their theories inferences based on imagination. In building up the theory of the circulation of the blood Harvey says why he thinks it is necessary for a thing to be so, and then by experiment proves it. There are no gaps in his presentation where facts are missing and where the omission must be supplied by invention.

Harvey's epoch-making book was a small one. It consisted of seventy-two pages written in Latin and was printed in Frankfort in 1628 by William Fitzer. The exact title was *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus*. It was republished in English in London in 1639, and has been reprinted many times. A very attractive edition was brought out on the three hundredth anniversary of its first publication by the Nonesuch Press in England. Harvey's second book has to do with the presentation of further proofs of the circulation, and consists of two letters written to Johannes Riolanus who was professor in Paris and the unforgiving and persistent opponent of Harvey's discovery. *"Exercitatio Anatomica Secundus et Tertius de Circulatione Sanguinis ad Joannem Riolanum Filium"* was published in Rotterdam in 1649, in Cambridge the same year, and in Paris in 1650. Harvey's reputation was made during his lifetime and he lived to enjoy the gratification that a general acceptance of his work must necessarily have brought. His last publica-

tion, issued when he was seventy-three years of age, was a book on the generation of animals—*Exercitationes de Generatione Animalium*—and was published in London in 1651 by Octavius Pulleyn. The frontispiece represents Jupiter holding in each hand half of a divided egg which is inscribed *"ex ovo omnia"* and from which is escaping several types of living creatures both known and unknown. So great was Harvey's reputation that this book was immediately pirated and three editions were published in the same year at Amsterdam from the presses of Jenssen, Ravesteyn and Elzevir. Harvey's studies on this second subject undoubtedly dated from his student days at Padua where we find that Fabricius had published in 1615 a book on fetal development.

Soon after Harvey discovered and demonstrated the circulation, others began the process of explaining the uses of the blood and the relation of the circulation to respiration. The physiology of respiration presented another clouded and mysterious problem similar to that of the circulation. Men were unable to answer the question as to why they breathed. Samuel Pepys in his *Diary* expressed his own mystification that physicians could not answer him satisfactorily on this point. Various indefinite and vague explanations were in vogue founded chiefly on the teachings of Galen, the general tenor of which was that the lungs served a purpose of refrigeration, cooling the blood and the adjacent heart, and that they gave off certain smokes or vapors from the body. The story of the circulation was carried to its conclusion by the explanation of the physiology of respiration

which required many men and many years to bring to a full scientific answer.

Robert Boyle, a chemist and not a physician, was the son of the Earl of Cork and was born in 1626 at Lismore Island, and died president of the Royal Society in London, 1691. He experimented with combustion and with the air pump, and proved that air was a necessity not only for animals to live but for fire to burn. His publications are to be found in the *Proceedings of the Royal Society of England.* Robert Hooke, an English chemist, showed about 1667 that a dog could be kept alive without any movement of either chest or lungs through an imperfect form of artificial respiration by blowing air from a bellows briskly over the open thorax of the animal. Richard Lower lived in Great Britain (1631-1691) and practiced medicine in London. He added much detail to the anatomy of the heart. In 1669 he injected dark venous blood into insufflated lungs and concluded that the resulting bright color of the blood was due to the absorption of some of the air in the lung while the blood was passing through this organ. John Mayow (1645-1679), another London physician, studied the physiology of respiration, and although he died comparatively young man at thirty-four years of age, he added to human knowledge. Mayow demonstrated that dark venous blood is changed to a bright red color by absorbing a certain ingredient from the air which he called nitro-aerial spirit. The nitro-aerial spirit was not identified until one hundred years later, when Joseph Priestley in 1774 manufactured a new gas in the laboratory and named it dephlogistonated air.

Antoine Lavoisier, a Frenchman who lost his life in the French Revolution by the guillotine, corroborated in 1775 the work of Priestley and discovered the true nature of the gaseous exchange which took place during respiration in the lungs. He demonstrated, in conjunction with Laplace, that respiration is in every way analogous to combustion. Finally, Hermann von Helmholtz demonstrated in 1848 that the old theories of the heart as the source of heat were fallacious, and that the muscles were the main contributor to animal heat which was produced by the chemistry in muscular tissue associated with the consumption of oxygen.

VIII

LOCKE AND SPENCER

The Medical Philosophies from the Seventeenth to the Nineteenth Century

When the attacks of Paracelsus, the studies in anatomy of Vesalius and his followers and the epoch-making discovery of Harvey had resulted in the overthrow of the Galenical tradition, medicine seemed to have lost its foundations. The thoughtful members of the profession were not slow to build up a new one. Just as the medicine of Greece was in close touch with the philosophers, and especially with Plato and Aristotle, so medicine came in the seventeenth century under the influence of Descartes and Locke, representatives of the materialistic, and of Leibnitz, teacher of the spiritual philosophies of their time.

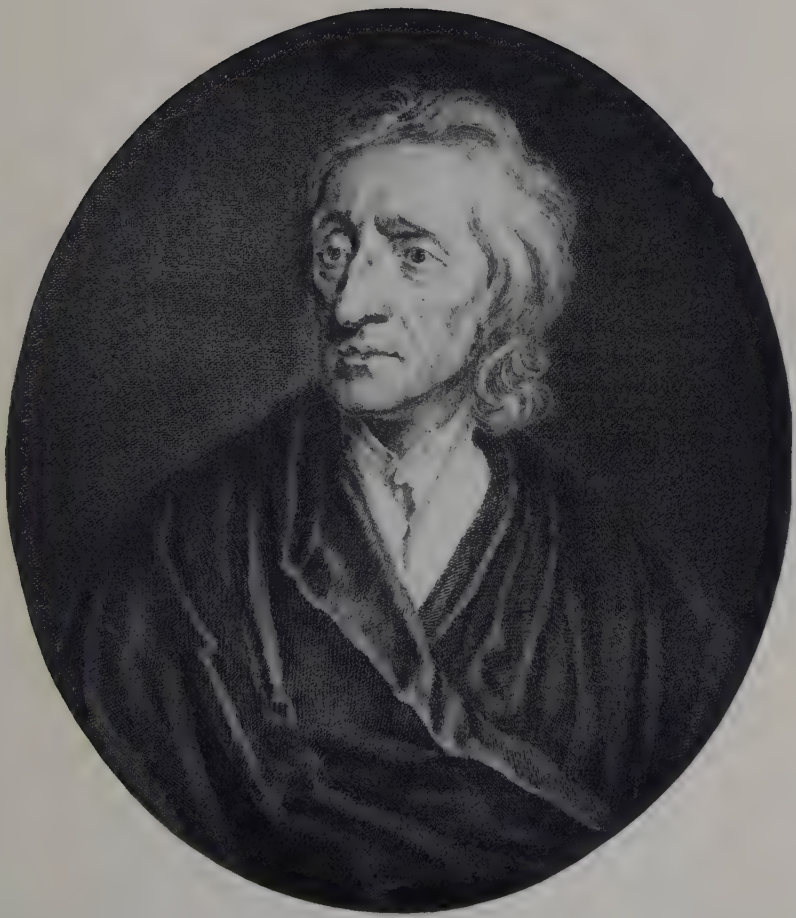
René Descartes

René Descartes was born in Touraine in 1596. He was a great wanderer, and lived in the course of his voluntary exile from France in Holland and in Bavaria where he served in the army. Later he traveled through Germany, returned to France after nine years' absence and finally spent nineteen years in Holland. He died in 1650 in Stockholm where he had just founded an Academy of Science in the service of Queen Christina.

Most of his literary work was done during his long sojourn in Holland. He was essentially a mathematician and not a physician, but his studies of philosophy led him into close relationship with medical thought. In philosophy he was a materialist, believed that all living creatures were machines and that science could investigate only the laws founded on mathematics which govern the movement of these animated machines. He endowed man only with an intelligent soul which he located with mathematical precision in the pineal gland of the brain. Descartes denied the primal cause of Aristotle and substituted therefor what he called an occasional cause. His explanation of life rested entirely upon chemical, physical, mechanical and mathematical relations and the laws governing these.

John Locke

John Locke (1632-1704) spent his early years at Oxford in the study of chemistry and physics; later he turned to medicine and took his bachelor's degree at the age of forty-two. He is better known as a philosopher than as a physician. In London he was intimate in the company of Sydenham, Newton and Boyle. His chief book, *Essay Concerning Human Understanding,* was published in 1670. Locke followed the line of reasoning of Descartes and founded the School of Empiricism in England. When Leibnitz visited England he met Locke and is supposed to have discussed the views on nature and medicine which each held. The philosophic differences of these two thinkers is shown in the



From an engraving by Vertue of a painting by Kneller in Birch's HEADS OF ILLUSTRIOUS PERSONS, in Author's Collection

Figure XI

LOCKE

short exchange of ideas alleged to have passed between them thus: *"Locke loquitur 'Nihil est in intellectu quod non autem fuerit in sensu,' et respondit Leibnitz, 'Excepto ipso intellectu.'"* "Locke said, 'There is nothing in the intellect except what was first in the senses,' and Leibnitz responded, 'The intellect itself having been excepted.'" The portrait of Locke is a copy of an engraving by Vertue from the painting by Kneller from the collection of prints published by Birch (Figure 11).

Leibnitz

Leibnitz, like Descartes, was also a mathematician, and an active participant with Newton in the discovery of the differential calculus. He was born at Leipzig in 1646 where he cultivated all the sciences, especially mathematics and law. He traveled in Holland and England, and settled in Hanover where he died in 1716. Leibnitz believed that matter and its movements were only phenomena. He explained these concrete elements of nature as coming from indefinable and invisible cause which he visualized mentally as a metaphysical point, likening it to a mathematical point. As applied to life Leibnitz considered the human being to be a material thing, a "monad," the human soul to be a "point," and thus he divided the life of man into matter and spirit. This reaffirmation of a soul distinct from the material body gave rise to the Philosophic School of Medicine which became prominent in the eighteenth century, and which was known as the Vitalist or Animist School.

Jean Baptiste van Helmont

While Harvey was working over his demonstration of the circulation of the blood Jean Baptiste van Helmont was developing a new point of view in regard to medical chemistry. Van Helmont (1577-1644) was almost the same age as Harvey. He was a Belgian born at Brussels, and one of the nobility. Chemistry and botany attracted him in the beginning of his studies in the University at Louvain. He became interested particularly in the writings of Paracelsus, and suddenly decided to devote himself to medicine. Van Helmont was a neurotic, subject to nervous attacks, and a mystic similar to Paracelsus himself. He attributed to chemical processes an exclusive influence in all the relations of life in both health and disease. He advanced a new theory of the action of ferments as the active agents through which chemistry held its sway over the body. He subsequently extended his theory to include the ferment as the apparent cause of all transmutations in nature. Second to the ferments and of almost equal importance he placed the activity of water. He adopted the theory of Hippocrates of a vital spirit which controlled the chemical reactions of the ferments, and he attributed all symptoms of disease to the contest between this vital principle which was endeavoring to overcome the toxic ferments by means of others which had healthy action. In addition to being a nervous hysterical person, van Helmont was also a chronic dyspeptic. In his books he describes his own symptoms in detail, and makes possible a diagnosis of achylia gastrica with dilation of the stomach.

Van Helmont's theory of ferments was adopted by the great clinicians of England of the time: Willis and Sydenham. This chemical school known as Iatrochemical was spread through Germany by Daniel Sennert, and through Holland by Francis Sylvius. These members of the chemical school were not blind followers of van Helmont; they were all clinicians who studied disease in the true spirit of Hippocrates, and added much to increase medical knowledge and to advance the art of differential diagnosis. They added by their accurate descriptions many new diseases hitherto unknown to the profession. Willis, who was well-known also as an anatomist of the brain, described diabetes, and Sydenham described in modern language the gout, chorea, from which he himself was a great sufferer, and recognized hysteria as a disease of the nervous system. The times were ripe for development of good clinicians, especially in England which was the site of many diseases. Malarial fevers, eruptive diseases, epidemic influenza, tuberculosis and dysenteries were common over the whole country. At this opportune time ipecac and cinchona bark were introduced from the New World. These therapeutic novelties were very much needed and added a great deal to the success and reputation of the Iatrochemical School.

William Harvey and his discovery of the circulation gave an impetus to an entirely new theory of life and the structure of the body, and there grew up within the profession of medicine a group of physicians who placed all the processes of physiology, both normal and pathological, on a mechanical basis. The body was a machine.

This idea was advanced and supported by the striking advances of the time in the science of physics; the discovery of the thermometer, barometer, microscope and telescope turned the minds of men predominantly to mechanical and mathematical science, and medicine followed suit. The Italian School became converted to this point of view, and combated the ideas of the chemists and their new mineral and vegetable drugs. A bitter contest of the schools followed and centered on the question of a single drug. The chemists, following the writings of Paracelsus, had endorsed the use of tartar emetic. No drug has been a greater bone of contention in the profession. It is a powerful emetic acting not only directly on the stomach but, like seasickness, through the nervous system as well. The doses given by the Iatrochemists were appalling, and its severe action was recognized by the whole profession. The advocates for the drug probably attributed the toxic symptoms of their medication to the disease and the good feelings which the patient experienced after recovery from an acute attack of antimony poisoning to the beneficent effect of the drug, and not to the patient's recovery from the therapeutic "disease." The opponents of the drug undoubtedly attributed all the bad effects of the diseases for which the drug was used, and it was used for all, to the use of the tartar emetic, and not to the disease. The controversy increased to such an extent that the Medical Faculty of Paris passed a decree in 1556 against the use of antimony, and later when Joseph DuChesne advocated antimony the Faculty of Paris again condemned the drug in 1615.

The medical profession was always an exclusive and jealous body, but there never was a time in the history of medicine when the feelings of the faculty were more intolerant of any physician who brought forward new ideas or new proposals, particularly in regard to treatment, than was the fact in the seventeenth century. It is well-expressed in the description of DuChesne by Guy Patin who called him "a great drunkard, an ignorant person, in fact, a monster because he is a chemist, and because the best chemist is of very little use in the world, and this particular one has done more harm than all those who have followed or imitated him." It was at this same period that John Riolan, good anatomist as he was, could never accept William Harvey's discovery of the circulation of the blood.

A picture of the profession of the day is shown in the plays of Molière, especially in *Le Malade Imaginaire,* written in 1673. In a farcical picture of the installation of a bachelor candidate for the degree of Doctor of Medicine Molière portrays the errors of his time in a mixture of French and Latin. To every question there is only one answer:

SECUNDUS DOCTOR:

"Quæ sunt remedia
Quæ, in maladia
Ditte hydropisia
Convenit facere. . . ."

QUARTUS DOCTOR:

. . . "Habet grandam fievram
cum redoublamentis,
Grandam dolorem capitis,

Et grandum malum au coté,
Cum granda difficultate
Et pena de respirare:
Veillas mihi dire,
Docte Bacheliere,
Quid illi facere?"

The candidate has the same answer to all:

BACHELIERUS:

"Clysterium donare,
Postea seignare,
Ensuita purgare."

and to the dilemma of non-success in treatment:

QUINTUS DOCTOR:

"Mais, si maladia
Opiniatria
Non vult se garire
Quid illi facere?"

the bachelor repeats with a final:

"Reseignare, repurgare, et reclysterisare."

This can be set to the modern fads of some schools of practice.

Purge and purge once more
Vaccinate now, and then again
Then add colonic irrigation
Or some newer irritation.

In Molière's parody the bachelor is praised in chorus:

"Bene, bene, bene, bene respondere.
Dignus, dignus est entrare
In nostro docto corpore."

and is finally given his doctor's degree and license:

PRÆSES:

"Ego, cum isto boneto
Venerabili et docto,
Dono tibi et concedo
Virtutem et puissanciam
Medicandi,
Purgandi,
Seignandi,
Perçandi,
Taillandi,
Coupandi,
Et occidendi
Impune per totam terram."

The antagonisms of the schools of medicine, one with another, the opposition of the physician to the apothecary, the idolatrous worship of tradition by the faculty in control of the university, the exclusive intolerance of one group of physicians for another, stand out prominently in this period of development. When one compares it with the true clinical acumen of such men as Sydenham and Boerhaave, and with the patient, painstaking, scientific habit of experiment of William Harvey, and other investigators of the following years, it leads one to wonder why the truth prevailed at all.

The final result of the Chemical and Mechanical Schools of Medicine was a combination of the two which was controlled largely by the doctrine of Descartes that there existed in nature only matter and movement. The old causes of Greek philosophy were no longer thought of, and the occasional cause due to chance external conditions remained. Nothing was left but the study of

the laws of nature which were placed entirely on a mathematical basis. The theory of Bacon, accepting only laws discovered from experiment and observation, combined with the Cartesian philosophy left the medical profession in a state of skepticism as to all facts which might at any time in the view of that accepted philosophy be overthrown and changed by the further study of nature.

George Ernst Stahl

The first attempt to combat this iatromechanical philosophy was brought about by George Ernst Stahl who was born at Ansbach in 1660, was made professor at the newly established university at Halle, and who died afterward at Berlin in 1734. Stahl returned to the philosophy which affirmed the existence of an immaterial and immortal soul united with the material body in some sort of combination. Force, faculties, movements are the results of the action of the soul which is also the active element in thought and intelligence. Stahl's doctrine came from the influence of Leibnitz, and has been called animism. He does not return to the Platonic theories, denies the assumptions of specific action endorsed by Galen and substitutes therefor what he calls a tonicity of all the activities of the body such as the secretions, excretions and the circulation upon which life unconsciously depends. He explains disease as due to the tendency in all living matter to decay and putrefy. The soul combated and prevented this while it resided in the body, but upon its departure, death and decay re-

sulted. Stahl was greatly impressed with the effect of the mind upon the health and disease of the body, and was a forerunner of the modern theories or cults which emphasize this view-point. Stahl was also known for his "theory of combustion" in which he explained that in combustion a substance which he called phlogiston was given off. Although others had already shown that substances in burning gained rather than lost weight, Stahl's theory because of the credence it was given delayed the accurate explanation of combustion. Stahl's philosophy is profound and somewhat vague but written in a very assertive manner, and he is particularly to be noted as the founder of animism and the restorer of an immortal soul to medical philosophy.

Albrecht von Haller

The most celebrated pupil of Hermann Boerhaave of Leyden was Albrecht von Haller who made a more lasting impression on the science of medicine than had his teacher. Haller was born in Bern, Switzerland, in 1708. He studied medicine at Leyden, after which he practiced in the city of his birth until called to the University of Göttingen where he was Professor of Medicine from 1736 to 1753, at which time he returned to Bern, and died in 1777. Haller was a many-sided genius, interested in a broad variety of human activities. He wrote poems and novels, compiled a noteworthy medical bibliography, was a pioneer among medical historians and held a reputation as both a botanist and a physician.

As a physician, he devoted much more time to medical research than to practice. He was an industrious

experimenter, and his work forms the first mile-stone in modern physiology. In this work he distinguished and showed by experiment the difference between sentient and irritable structures. In his essay on sensibility and irritability he says: "I call an irritable part of the human body that which becomes shorter (contracted) when it comes into contact with a foreign body. I call sensitive fibre in man that which, being touched, transmits the impression of this contact to the brain." In other words, structures were sensitive because of and in proportion to their nerve supply, and muscles were irritable and contractile independent of their nerve supply. He pointed out that irritability survives after the death of the animal. The question of irritability and sensibility was pertinent to the discussions which went on during the eighteenth century between the adherents of the various systems which undertook to explain theoretically the meaning of life. The Animists and Vitalists felt that all matter must be passive unless possessed of some activating principle or force such as the soul, or some hypothetical agent independent of the soul which Barthez called vital principle. The Animists considered life and the soul the same; the Vitalists held that in addition to the soul there was some agent which they called the vital principle which maintained life; the Organicists regarded life, on the other hand, as the result of bodily processes and not the cause of them, that matter was possessed of irritability and that life was the response to outside stimuli or, in other words, to a series of reflex actions.

William Cullen

The formulation of schools of medicine did not end with these theoretical philosophies but took on a more practical form. Every new discovery in science led to some development or new theory in medicine. The work of Galvani and Volta on electricity stimulated without doubt the ideas of Haller on irritability, of Cullen on spasm and of Brown on excitability. Cullen's philosophy on close analysis does not differ materially from that of Descartes. He is better known as a clinician than as a philosopher. He was born in Lanarkshire, Scotland, in 1710, studied medicine in Glasgow, and became professor at Glasgow and later at Edinburgh where he died in 1790. His descriptions of disease were exact for he was a clinical observer of great skill. He was the controlling spirit of the Edinburgh School at the time when the earliest American physicians were students there and had a marked influence on the development of American medicine. His great addition to internal medicine was his habit of thought in explaining diseased activity in the body as the result of normal physiological acts.

During the rise and fall of these various philosophies in medicine there was always a group of observers active in studying disease at the bedside irrespective of their adherence to this or that theoretical explanation of the phenomena of life. The appreciation of Hippocrates and the study of nature did not die, and at this period also there was a distinct tendency to study the writings of the older physicians, and to keep in touch with his-

torical medicine. Two of the best histories of medicine were written in the eighteenth century: that by Daniel Leclerc (1652-1728), of France, which had to do only with medicine down to the time of Galen, and that written by John Freind (1675-1728), of Croton in Northamptonshire, who laid particular stress upon the medicine of the Arabians. The *Histoire de la Medicine* of Leclerc was first published at Amsterdam in 1696, and *The History of Physick,* by Freind, was published in London in 1725, the one book being a continuation of the other. It was in the beginning of the seventeenth century also when the attacks on Hippocrates and Galen were most strenuous that René Chartier published his great edition of the works of Hippocrates and Galen.

John Brown, Broussais and Despars

John Brown (1735-1788) was a Scotchman who attempted to reform medical practice. He had a distinct leaning toward the mysticism of van Helmont. He developed his theory in his own person during a prolonged attack of gout which in spite of treatment applied by his colleagues, *secundum artem,* did not come to an end. He finally freed himself from his affliction by the use of excitants. His treatment consisted of the free use of alcoholic beverages, large amounts of food, local applications of cold and considerable doses of opium. Brown considered living tissue as "excitable" and that life in the absence of excitation could not exist. In this way life could be compared with a furnace fire which might burn brightly or be consumed as it was given

proper or excessive drafts, or smolder and go out because the draft was insufficient. Disease might result from insufficient excitation resulting in an asthenic state or from too much excitation when a sthenic condition resulted.

Diseases resolved themselves therefore into these two groups: sthenic and asthenic, and required depressant or stimulating treatment. The drugs which supplied these qualities most successfully were opium and alcohol. The physician's only duty is to watch for the changes which occur in the excitation, and to lead them by proper means to the point where disease disappears and health is resumed. By this theory Brown proposed to make a definite science out of medicine which hitherto had been a speculative art. It sounds all too simple, and is far removed from the scientific observation of a Hippocrates or a Sydenham.

Brown's School of Medicine had a great vogue for half a century. It was modified by Rasori (1761-1837) in Italy, who followed in the footsteps of the earlier Iatrochemists and pinned his whole faith upon large doses of tartar emetic, reverting to the practice of Paracelsus and his followers. Brown's theories of medicine were continued in France by Broussais (1772-1838) who extended the ideas of Brunonianism in a new form. Broussais by training was a soldier and showed a soldier's carelessness to the letting of blood, and in some cases applied as many as fifty leeches at a time. He carried his doctrine of inflammation caused by irritation to the logical extreme of therapeutics by phlebotomy and repeated phlebotomy. Broussais had a certain effect

on medical treatment for a time, and it took several decades for others to counteract the popularity he gave to this method of treatment. He did as much as any one to destroy his own influence not only by adhering to a single and exclusive tenet in medical practice but also by his opposition and antagonism to the School of Observation and Scientific Study led by Laennec and his followers in the hospitals of Paris.

Jacques Despars whose work on Avicenna was published in Venice in 1491 praises phlebotomy to the highest in a series of Latin verses which might easily have been an anthem dedicated in honor of the practice of Brown and Broussais:

Phlebotomia	Phlebotomy
Longiorem vitam	Ministers to a long
Sanitem ministrat	And healthy life
Sanguinem alienum ejicit	Eliminates all vitiated blood
Proprium sanguinem nutrit	Nourishes healthy blood
Tristitiam sufert	Removes sadness
Memoriam præbet	Stimulates the memory
Vesicam purgat	Purifies the bladder
Cerebrum temperat	Calms the brain
Stimulum libidinis fugat	Induces continence
Auditum aperit	Sharpens the hearing
Lacrymas stringit	Dries up tears
Stomachum purgat	Purges the belly
Digestionem invitat	Improves digestion
Leniorem producit vocem	Favors a gentle speech
Visum acuit	Sharpens eyesight
Ventrem coercet	Removes costiveness
Sommum minuit	Induces sleep
Anxietatem tollet	Relieves anxiety
Ingenium acuit	Raises the spirits
Medullas calefacit	Warms the marrow

It would seem that this optimistic Latin invocation might have been added to the prayer prevalent in the churches at the same period: "From the Turk, the Plague, and the Comet, Good Lord deliver us."

Samuel Hahnemann

The use of excessive blood-letting became the curse of medical practice in the early nineteenth century, and led to a distinct reaction against the rough and drastic methods of treatment which had so long been in vogue. Under this reaction and the stimulus of the studies of the French School and of the pathological studies first begun by Morgagni, a new method of study and treatment of disease began. This was known as the expectant method. It consisted very largely of leaving the patient alone, and allowing an acute disease to run its natural course by carrying out the three great therapeutic aphorisms which had been inherited from ancient writers: first, that of Hippocrates to imitate nature, directing the course of a disease to recovery; second, that of Paracelsus, to sustain the patient's strength while the disease runs its course, and third, that of van Helmont, to search out and apply those specific remedies which experience had proved of value. Coexistent with this development of the regular profession the last school to bring forward an exclusive theory in the treatment of disease was founded by Samuel Hahnemann (1755-1843). Whereas Rasori claimed that excessive doses of a drug like tartar emetic would have not only a different effect but an opposite effect from that which followed the use of smaller doses, Hahnemann taught that infinitesimal doses of a drug would have an increased effect over its usual therapeutic administration. Hahnemann returned to the theory of Paracelsus concerning similars. His exclusive law of therapeutics was embraced in the

statement, *"Similia similibus curantur."* Hahnemann described three possible therapeutic methods: the antipathic which is characterized by the dictum of Galen *"Contraria contrariis curantur"*; the allopathic method in which medication is given with the object of producing in the patient an effect different from those of which he complains and which naturally belong to the disease *"Allia alliis curantur"*; and third, the homeopathic method or law of similars which he adopted as the only allowable one applicable to the treatment of disease. In order to reenforce his theory Hahnemann claimed the possibility of potentization by which a drug increased its normal power through agitation if liquid, or by trituration if solid. Medicines under the Hahnemann theory were given singly in accordance with the presence of individual symptoms.

Homeopathy had but slight effect on the practice of medicine in Europe. In America, on the other hand, it had a great vogue, and was taken up by members of the regular profession. Its success was due in part at least to the traditional spirit of intolerance on the part of the regular practitioners in their conduct toward their homeopathic colleagues who dared to embrace these new and heretical doctrines. Professional ostracism and social martyrdom did not tend to produce scientific results, and throughout the United States a large following and distinct school of medicine was developed under the ægis of the name of Hahnemann. Homeopathy served a useful end as a protest against the polypragmatic pharmacy and the excessive use of bleeding which was prevalent during the first half of the nineteenth

century. It helped the profession to realize and to emphasize that among the aphorisms of Hippocrates was the statement that certain diseases got well and ran a limited course without medication, and as a natural result of the self-limited nature of the disease itself. Homeopathy has not been able to withstand the logic of events which have followed the scientific development of medicine in diagnosis and therapeutics of the twentieth century, and it is quite certain that no homeopathic physician exists to-day who limits his practice exclusively to the theories of Samuel Hahnemann.

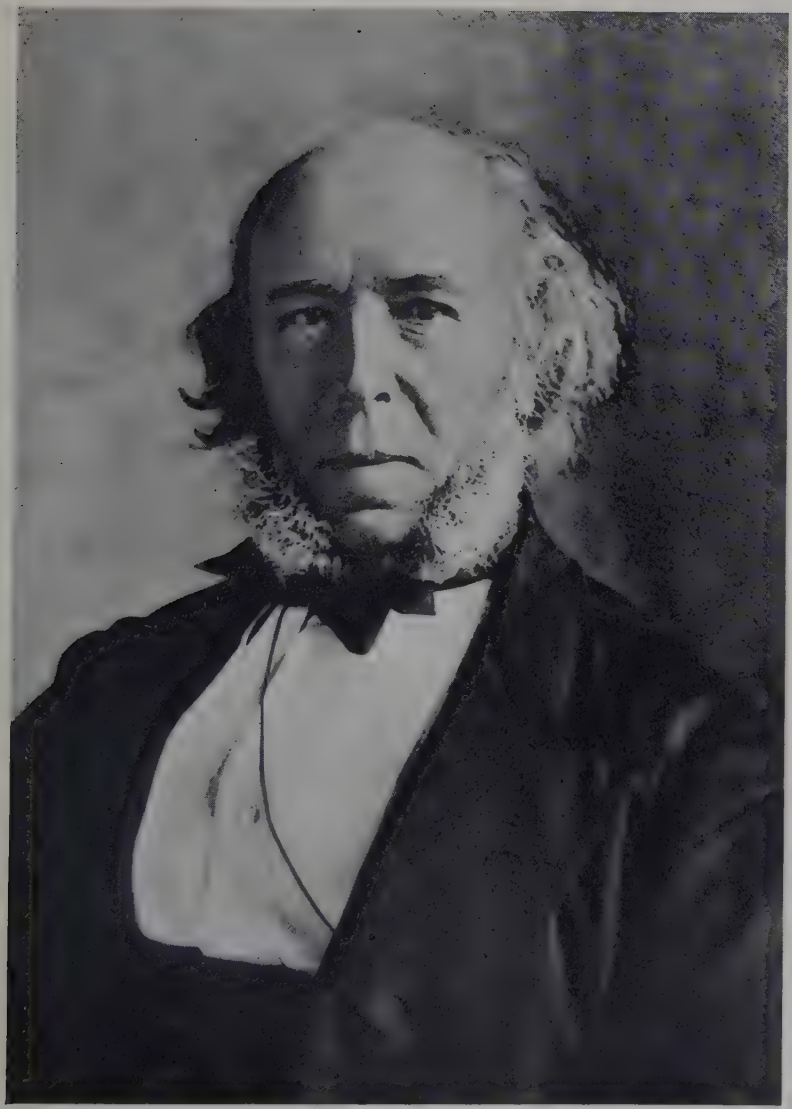
It is an exceedingly interesting fact that in the city of Washington there has been set up a statue of Samuel Hahnemann, the physician. This was brought about by vote of Congress of the United States at the instance of a homeopathic physician who was a member of Congress. This statue is a very artistic production on the base of which there are inscribed the words, *"Similia similibus curentur,"* which being phrased in the subjunctive mood will, it is certain, be subscribed to by every physician whatever his practice or education.

Spencer

During the early part of the nineteenth century medicine was busy with its own development, and physicians began to modify philosophical views in accordance with the development of their own science and of general biology. Virchow's dictum concerning this attitude, *"Omnis cellula e cellula,"* represented the trend of thought. In the same year, 1859, in which Virchow published his

cellular pathology, Darwin stirred up the world of science and of religion with his *Origin of Species,* and placed a well-thought-out theory of evolution on the basis of natural selection in a printed book. The time was ripe for a new philosophy and its exponent was found in Herbert Spencer. Herbert Spencer was a bachelor who lived for eighty-three years (1820-1903). He formulated the plan for his synthetic philosophy in 1860 and carried it through to completion after thirty-six years of untiring labor in 1896. He led the life of a student isolated from the world and took no part in the controversies and antagonisms of his contemporaries even when they were aroused by his own writing. His portrait shows a quiet English gentleman of the Victorian era and gives no special suggestion of the brilliant analytical mind which animated his epoch-making work. (Figure 12.) The majority of the medical profession have subscribed to the new ideas which were formulated in blunt and unequivocal language by Spencer and fought over on the platform and in shorter articles by the belligerent Huxley. Thomas H. Huxley's presentation of Spencer's philosophy and of the new biology was described by him as an agnosticism, which did not consist in the denial of any theory or any fact but admitted as true only those things which could be proved and left everything else in the domain of the unknown. The unknown facts of one period might be proved later and then would be accepted. Biology became a science, passing through a process of evolution with the survival of those ideas, theories and principles which would be proved to succeeding generations as the fittest to survive.

Herbert Spencer's philosophy began with the state-



From an unsigned engraving in the Collection of The New York Academy of Medicine

Figure XII

SPENCER

ment that some things are unknowable, that it was inconceivable to think of a universe without end and without beginning because man's whole experience had to do with the finite and not the infinite. In Spencer's time the ultimate division of matter was the atom which was indivisible, a theory which he considered as inconceivable, and as a matter of fact science since his day has separated the atom into its electrons. Spencer also thought of the theory that matter was infinitely divisible as an equally inconceivable fact. His conclusion that the finite mind of man could comprehend neither of these concepts concerning the atom was applied also to space and time, for his whole idea of the unknowable was included in the point of view of any child who, to the dogmatic statement of the theologian that God made the world, would immediately ask: "Who made God?" Spencer accepted the theory of evolution and applied it to life, to mind, to society, to morals, and summed up his ideas in his definition of life: "Life is a continuous adjustment of internal relations to external relations." This philosophy, which is the logical sequence to the mathematical and material philosophies of Descartes, Locke and Leibnitz, is preeminently the philosophy of medicine to-day. Many great medical scientists, including Claude Bernard, Johannes Müller and Rudolf Virchow were animists, but medical science is now more concerned with the accumulation of material facts than with theoretical or philosophic considerations of the past antecedent to this life or of the future following it. Medicine is too busy investigating the unknown things that can be discovered to spend time upon the unknowable and unattainable.

IX

SYDENHAM AND BOERHAAVE

The Return to Clinical Medicine

In the early part of the seventeenth century the medical profession for the most part concerned itself in the discussions of the various theories of diseases, and individuals gave little time to original observation and effort aimed at the discovery of new facts. The adherents of the Iatrochemical School, as we have seen, regarded disease as the result of chemical fermentation within the body, and endeavored to correct this faulty fermentation by the administration of chemicals; the adherents of the iatromechanical theory regarded disease as an obstruction of the body channels by solid particles, and sought to relieve this blocking up by appropriate measures. Thomas Willis (1621-1675), of England, is best known to modern-day students as an anatomist because of his additions to knowledge of the anatomy of the brain, but he was also a great clinician. He adopted without reserve the theoretical considerations of van Helmont and the Iatrochemical School. His description of diabetes was accurate, and he was the first to formulate the symptom complex which makes up that disease. He was a contemporary of Sydenham and both did much to advance the rational and scientific spirit in the practice of medicine in England. Although Thomas Sydenham was an adherent of the Chemical School he is

spoken of as "the English Hippocrates." He discarded theory and led the profession back to a method of careful observation and to the practice of measures based on the physician's own practical experience uninfluenced by theoretical bias.

Thomas Sydenham

Sydenham was born in Wynford Eagle in 1624. He came from a family of gentlefolk residing in a district known for its strong Puritan leanings. The Sydenhams on the outbreak of the Civil War immediately embraced the cause of Cromwell. Thomas Sydenham's father, he himself and four brothers all served in the army of the Protector. His mother was killed during a raid by the Cavalier forces. The future physician occupied the rank of captain, and later in life was spoken of as the trooper turned physician. As a result of the unsettled conditions in England during this period Sydenham's education was interrupted. He attended Oxford for a few months but was called away to enlist. After the wars he returned and obtained a degree as Bachelor of Medicine. This degree was granted him in much the way that honorary degrees are granted by universities of the present day, in his case as a matter of patronage because of the service of his family to the Puritan cause. It is probable that his medical instruction consisted largely in reading and listening to the readings of Galenical and Hippocratic texts. At Oxford Sydenham formed lasting friendships with the physician and philosopher, John Locke, and the scientist, Robert Boyle. In addition to

his attendance at Oxford, he studied medicine for a period at the University of Montpellier, finally taking up private practice in London. Here although his blunt personality interfered with recognition by the Court and Court circles, which his ability deserved, he achieved a large reputation and practice. The portrait of Sydenham from the collection of *Heads of Illustrious Persons* is from the painting by Lely engraved by Houbraken. (Figure 13.)

Sydenham took Hippocrates as his model, and prided himself on his ability as an observer of disease. He set himself to describe accurately what he saw without allowing theoretical explanations of the observed phenomena to influence or distort these descriptions. He did not consider it within the compass of the human mind to comprehend the intricate processes of physiology, and doubted that detailed anatomical knowledge availed much to the practical physician in recognizing and curing disease. He knew very little of, or at least attributed very little significance to, the work of Harvey, Malphigi and others. When a young man about to enter the medical profession asked his advice as to what books to read Sydenham replied: "Read *Don Quixote*. I read him still." In other words, Sydenham felt that doctors were not made by the reading of books. The physician, he thought, should learn first to recognize different diseases as he recognizes one plant from another, and to explain the reasons for their differences afterward. In his writings Sydenham stated that fevers comprised two-thirds of all disease,—which was probably so in his time,—and one-half of the remaining third was included in what he

From an engraving by Houbraken of a Portrait by Leiy in Birch's HEADS OF ILLUSTRIOUS PERSONS, in Author's Collection

Figure XIII

SYDENHAM

called hysteria. Disease, he believed, resulted either from the entrance into the body of "morbific" material from the atmosphere, or the formation of morbific matter within the body as a consequence of the disharmony of the four humors. Nature in order to reestablish health attempted to purge the body of these matters. The physician should be ready to assist nature if her efforts were too weak, or to restrain her if her efforts were too vigorous.

Sydenham made the greatest impression on medicine with his treatise on fevers. He regarded the normal duration of fever as fourteen days. He arrived at this fixed standard probably by observation of cases of typhus which were very common at the time. Even with the intermittent fevers he asserted that the normal total of hours was the same in all cases. Fevers which lasted longer than this did so because of faulty methods of treatment. He believed that the type or character of fever varied with the season or year because of some external influence which he could not identify. It might arise in the atmosphere or from the "bowels of the earth," and he spoke of it as the epidemic constitution. He analyzed the fevers which occurred in London in several successive years. In one year the pestilential constitution prevailed and plague predominated; in another, the variolous constitution obtained and smallpox was the principal disease; in another, the dysenteric constitution, *etcetera.* In the light of present-day knowledge the explanation of epidemics on the basis of an "epidemic constitution" sounds very crude. Yet Sydenham was one of the first to emphasize the epidemic nature of

contagious diseases, and he may be said to have fathered the science of epidemiology. It must be realized that it took years for men to recognize such true factors in the spread of epidemics as microbes, the routes of human travel, or the transfer of flea-infested rats from one locality to another as in the spread of the plague. On the other hand seasonal and atmospheric influences occupy their place in modern conceptions of the spread of contagious diseases, as in Pasteur's ideas regarding the attenuation of viruses by external influences, and in the observation of other bacteriologists concerning the influence of the atmosphere on the growth of certain bacteria.

In Sydenham's day it was the usual rather than the unusual thing for an individual to have smallpox during his lifetime. He conceived smallpox therefore "as a purification or renovation of the blood" which occurred in the lifetime of every individual at least once. Moreover it was his opinion that smallpox was a mild disease which became severe only as a consequence of unwise treatment. This opinion aroused a great deal of pertinent criticism, and in the later editions of his works Sydenham omitted it. He possessed an ability like that of Hippocrates to describe disease pictures accurately and clearly. His descriptions of gout and renal calculus (kidney stone), from which he himself suffered for many years, are classical. He was one of the first to describe scarletina (scarlet fever), and it was he who gave this disease its name.

Sydenham emulated Hippocrates in his methods of treatment, and primarily his aim was to assist nature.

He spoke disparagingly of the prevalent methods of nursing and treatment, and said that strong and well men would succumb if they were subjected to the régime often instituted in the care of the sick. In manner he was kindly and sympathetic but could be firm and authoritative if the occasion demanded it. Although frequently resorting to bleeding, he never carried it to the excess others did. He was not the first in England to use Peruvian bark or cinchona which contains quinine, but he did make its use popular in the treatment of intermittent fevers. Another favorite remedy of his was the use of steel filings in the treatment of chlorosis (anemia), an anticipation of the present use of the salts of iron. Sydenham had great confidence in the helpfulness of opium and introduced a form of laudanum prepared with wine, which bears his name,—Sydenham's laudanum.

A method of treatment used by Sydenham, which seems quaint to us at present but was probably accepted without much comment at the time, was the "putting of a child or young person to bed with an invalid" with the idea that vitality would be imparted to the invalid. Sydenham relates the use of such treatment in one case as follows: "One Mr. Little had a fever about seven weeks, and at the time was so far spent that his doctor judged him a dead man. He was ancient and having been treated with violent medicaments was as weak as ever I saw any that recovered. Other treatment having failed, I told his wife that nothing could preserve his life but the putting a boy to bed with him. So she procured a Link Boy to lie very close to him all night. The next morning I found his fever almost off, and his eye

and countenance more lively, upon which I pronounced all danger to be over, yet afterwards, upon the recess of the boy, he began to relapse, but the boy being got again, without any more treatment he perfectly recovered." He used this procedure with similar success in the case of Bishop Monk's lady, but the girl who slept with her developed a sickness herself. Such a result would naturally not seem unexpected to us, and the girl's illness was attributed to having lain with the lady. Sydenham scoffed at this, and the girl's recovery absolved him from blame.

Sydenham was a great sufferer himself, developing gout before the age of thirty. His attacks often incapacitated him for weeks at a time, and later in life he developed a kidney stone which frequently gave him painful attacks of colic. In England during his lifetime he was subjected to many attacks and criticisms by other members of the profession of which he often complained to his friends in his declining years. His books were written in Latin, and as a consequence were available to the profession on the Continent. His opinions were highly valued and acquired great authority throughout Europe. He died in 1689, and was buried in St. James's Church, Westminster, where a tablet erected by the College of Physicians bears the words "A Physician Famous for All Time."

Hermann Boerhaave

Among Sydenham's continental admirers was the celebrated Dutch clinician, Hermann Boerhaave (1668-

From an engraving by Houbraken of a portrait by Wandelaar in Birch's HEADS OF ILLUSTRIOUS PERSONS, in Author's Collection

Figure XIV

BOERHAAVE

1738), of whom it was said that he never referred to Sydenham without taking off his hat. Boerhaave was born near Leyden, the son of a poor but cultured clergyman. He showed promise as a student and was forced to support himself at college by tutoring others. At the age of thirty-three he was appointed Associate Professor of Medicine at Leyden, and in this position rapidly developed an international reputation as a teacher. Wandelaar had drawn a portrait of Boerhaave from life which was engraved by Houbraken and which presents the frank kindly face of the man who continued the new methods of clinical medicine and observation begun by Willis and Sydenham in England. (Figure 14.) From the standpoint of the progress of medicine Boerhaave's influence hardly outlived him, but he was the source of inspiration to a large number of brilliant students and followers. If he belonged to any school it should be said that he was an Eclectic as he chose what seemed best to him in iatrochemical and iatromechanical doctrines. He wrote a text-book on chemistry summing up the chemical knowledge of his time, but in his theories of disease he favored chiefly the ideas of the Iatromechanicists. Roughly he considered the body to consist of solids composed of fibers and vessels, and of fluids contained in the vessels. The fluids and solids acted upon each other according to the laws of hydrostatics. In disease the fibers became relaxed when congestion resulted, or constricted when there was a suppression of secretion, or the humors, or fluids might become excessively acid or viscid.

In treatment Boerhaave showed wisdom and common

sense, and had confidence in his remedies which he imparted to his patients. He was a great believer in bleeding, and recommended in pleurisy that "the patient be blooded largely with a quick running stream out of a great vessel, and a large orifice, keeping his body quiet and leaning backwards, enforcing his breathing all the while with coughing or panting, applying fomentations to the affected side at the same time, and gently rubbing it." This bleeding, he advised, was to be continued until the pain was abated, unless a fainting fit intervened. Few physicians have attained the celebrity of Boerhaave; students came to him from all over, and patients flocked to him, kings and princes among them. A letter addressed from China "To the Illustrious Boerhaave in Europe" reached him. His fellow townsmen in Leyden celebrated his recovery from an illness by illuminating the city. He was a man of attractive appearance, an eloquent speaker, kindly, dignified and unassuming in manner. His triumph was largely that of personality. On his death at the age of seventy he left his daughter a fortune of four million francs despite large and generous public gifts during his lifetime.

William and John Hunter

Clinical medicine advanced during the eighteenth century as during the seventeenth century in consequence of the observations of many men who added much to the knowledge of separate diseases. In this development of clinical observation English physicians took a prominent part. It is impossible to give the detail of

every new disease in the chronological order in which it was differentiated, or to present a list of every physician who added something new to medical knowledge. In this group none stands out more prominently than William and John Hunter who passed their active lives in London. They were both of the Vitalist School but were more prominent for their practical and scientific work than for their study of the theoretical questions which interested so many of their colleagues. John Hunter (1728-1793) in his adherence to the Vitalist School went further than others. He considered that all the body fluids possessed "vitality" and often repeated that he thought the blood was "alive." John Hunter was born of a gentle family of small means near Glasgow. As a boy he took no interest in school but preferred to study and constantly question others about nature, and the habits of animals and birds. As a consequence his primary education was largely neglected. His family prevailed on him to go to Oxford, but after spending two months at the university he left and occupied himself profitlessly until his brother, William Hunter, already a famous physician in London, offered to train him in his own profession.

William Hunter (1718-1783), a man of culture and education, had studied medicine in Glasgow under the clinician, Cullen, and the anatomist, Alexander Monro. Cullen was well-known as a clinician, and for his views on vitalism. Alexander Monro was the first of the three well-known Scotch anatomists of the same name—father, son and grandson—who in succession occupied the chair of anatomy at Glasgow for over a century.

After obtaining his preliminary education, William Hunter came to London where he became the pupil of the obstetrician, William Smellie. Smellie had been one of the first men to enter the practice of obstetrics in London. Previously, obstetrics had been largely in the hands of midwives who were often the daughters of doctors and clergymen. The midwives resented Smellie's intrusion into their field and opposed him in every way they could. Because of his ability, however, he acquired a large practice, published an authoritative textbook on midwifery and is remembered for his invention of a type of obstetrical forceps which bears his name.

William Hunter also built up a large practice in obstetrics, and was the first man to be employed by royalty as an obstetrician when he confined Queen Charlotte. In addition he was deeply interested in anatomy and surgery. He established a private school of anatomy, and gave lectures and conducted anatomical research in a private dissecting room on his own premises. His most important contribution to anatomy was his work on the anatomy of the placenta which clarified the prevalent ideas concerning the relationship between the maternal and the fetal circulation. The elder Hunter occupied a position of great influence in London, and acquired during his life a valuable and remarkable collection of books, paintings, etchings and coins which he left to the city of Glasgow. A weakness in his character was his jealousy and contentiousness which led him into disputes with his contemporaries, particularly with the Glasgow anatomists, the Monros.

John Hunter came to live with his brother, William,

and assisted him in his anatomical teaching and dissection. He found this work suited to his bent, and quickly acquired anatomical knowledge and skill. He did not at first readily settle himself to serious work but found a great deal of time for amusement. He found pleasure in the companionship of all sorts and even hobnobbed with the "resurrection-men" or grave-robbers with whom he dealt to supply his brother's dissecting-room with material. It was said that as a wit he excelled as a member of the gallery gods who frequented London plays, and gave their uninvited and audible opinions of the cast and acting. The portrait of John Hunter by Reynolds represents the studious side of his character rather than the social tendencies which showed his very human nature. (Figure 15.)

After several years of anatomical work his health broke down, and he received an appointment as an army surgeon. He was stationed at Belleisle on the French coast, and here conducted some of his first observations on the physiology of lower forms of animal life. At the beginning of winter he collected a number of lizards, and introduced into their stomachs earthworms and other food. He examined these lizards at different periods of their hibernation, and found that their digestion had become quiescent, and that the earthworms passed through their gastro-intestinal tracts unchanged. Returning to London, he interested himself in surgery. For a while he was resident house surgeon at St. George's Hospital, and later studied under the surgeons, William Cheselden and Percival Pott. Cheselden, who devised an operation for lithotomy by which he was able

to remove a stone from the bladder in forty-four seconds, was the author of a text-book on anatomy. He was an architect as well as a physician and designed the Putney Bridge. Percival Pott's name is preserved in medical nomenclature by the terms "Pott's Disease," tuberculosis of the vertebræ, and Pott's Fracture," a break of the lower extremities of the bones of the leg from which he himself suffered, both of which he described. Both Pott and Cheselden were men of great charm and ability who built up large surgical practices.

Practice came slowly to John Hunter, and for several years his annual income was a small one. He soon began the collection of specimens of every variety of animal, alive and dead, upon which he could lay his hand. Several years after beginning practice he purchased a place in the suburbs of London which he called Earls Court. Here was built from his own design a unique establishment. It included stables, cages and caves for the housing of animals, and rooms for preparing and mounting specimens. He made friends with museum keepers in order to obtain the bodies of wild or unusual animals, begged his friends who traveled in out-of-the-way places to be on the lookout for specimens for him, and during his life obtained from whalers the carcasses of three whales. The ends to which he would go to obtain an unusual specimen are illustrated by the story of the Irish giant famed throughout England for his height. The giant during his life had a horror of having his body dissected, and provided in his will elaborate ways of safeguarding his body until it could be buried at sea in a leaden casket. Upon his death Hunter's man,

Howison, who had been keeping track of him, informed Hunter of the whereabouts of the body which was being guarded by several men. Howison sent one of the men to Hunter who was waiting at a near-by inn, and who offered them fifty pounds for the body. By dint of bargaining the price was raised, and Hunter finally obtained his prize for five hundred pounds. This skeleton became one of Hunter's most highly prized specimens.

The investigation of the anatomical structure of lower animals is of great importance in the understanding of human anatomy. Some of the structures of human anatomy are complex and difficult to understand. In the lower animals these same structures are simpler, and the understanding of them helps in the explanation of the same and more complicated structure of the human. Hunter was a great contributor to the science of comparative anatomy.

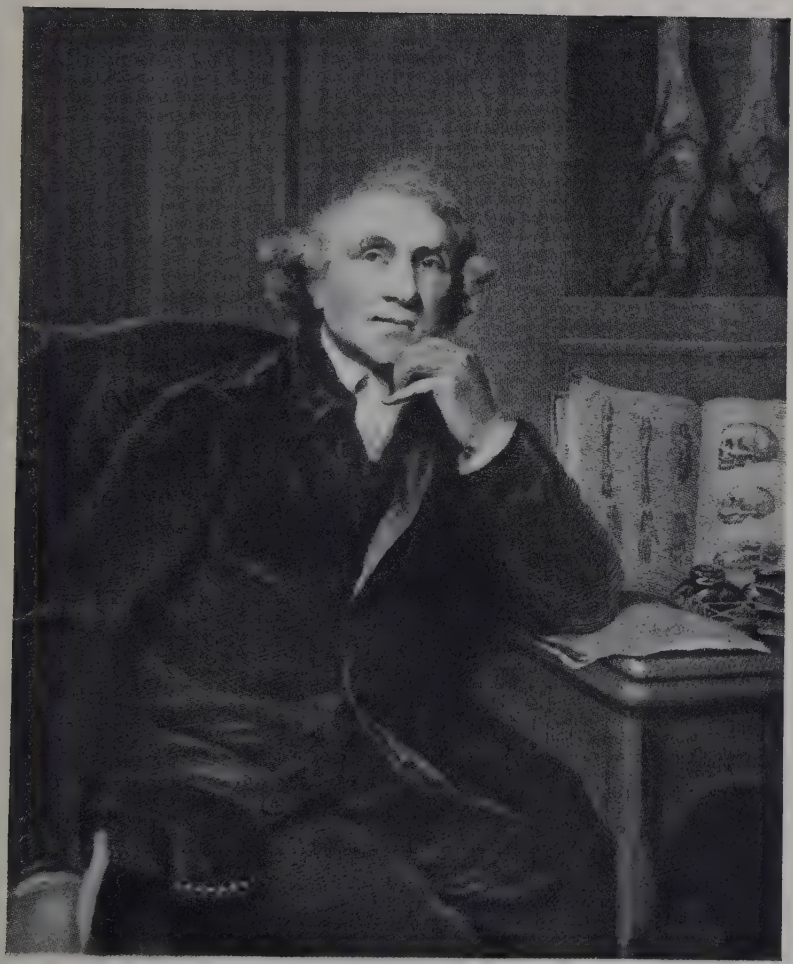
Hunter's practice grew gradually, and eventually he acquired one of the largest practices in London. He founded an anatomical and surgical school of his own where he enrolled a large number of students to whom he lectured three times a week during the winter. He became Surgeon in Ordinary to the King, Surgeon General of the Army and Attending Surgeon to St. George's Hospital. His day began at five or six o'clock in the morning, and he usually slept but five hours at night. His waking hours were crowded with work of one kind or another, but with it all he managed to find time for some social diversion.

Hunter's greatest contribution to surgery was his method of operation for aneurism,—a dilatation of an

artery due to weakening of its walls. This operation has been the means of saving thousands of lives and limbs. By this method the artery is tied off by a single ligature well above the diseased area. When this is done the tissues ordinarily supplied with blood by the tied artery are not deprived of their blood supply but come to be supplied by other arteries or branches of the same artery above the ligature by what is called a collateral circulation. Hunter discovered the principles of the collateral circulation by observation of the circulation in deer's antlers. A number of other contributions to operative technique, particularly in relation to the surgery of the blood-vessels, and to the treatment of gunshot wounds, were made by Hunter. He was the first to classify the teeth as molars, cuspids, bicuspids and incisors, and to recommend the removal of the tooth pulp before filling.

Three years before the elder brother's death William and John Hunter became engaged in a public quarrel concerning the priority of the discovery of certain facts about the placental circulation. The breach was never healed, but John Hunter came to regret it, and after William's death often spoke with a great deal of emotion of the respect in which he held his brother.

During the last few years of his life John Hunter suffered from attacks of angina pectoris. At first these attacks were far apart but gradually became more frequent, coming on even while he was in bed. He wrote of the progress of the disease in himself with minute descriptions of the individual attacks. He found that mental stress and anxiety brought them on as well as



From an engraving by G. Adock of a painting by Reynolds, in Author's Collection

Figure XV

JOHN HUNTER

physical exertion, and came to say that "my life is in the hands of any rascal who chooses to annoy and tease me." At a meeting of the managers of St. George's Hospital in which he was trying to persuade them to render greater service to medical education by sponsoring clinical lectures he was strongly opposed by some of his colleagues, and died during the meeting in an attack of angina. Upon his death Hunter left his widow and children almost nothing of value except his great rambling house which with its outbuildings and stables covered three blocks. This housed his magnificent collection upon which he had probably spent seventy thousand pounds during his lifetime. It consisted of over thirteen thousand specimens, including dissections of human anatomy, stuffed birds, animals, fossils, *etcetera*. After much negotiation the collection was finally purchased by the government for a sum which enabled Mrs. Hunter to live comfortably for the remainder of her life. Hunter was buried in St. Martins-in-the-Fields, but in 1859 the body was removed and reinterred in Westminster Abbey.

All the chicanery of the eighteenth century was not concentrated in the pursuit of medicine. London had at the same time its group of literary fakers who abode and worked in and about Grub Street. This locality has become a title for all time for cheap and purchasable authorship. Grub Street is personified in the first quarter of the eighteenth century in the bookseller, Edmund Curll, who was a piratical publisher and of interest in the history of medicine of that period. When Curll fell foul of the law he dodged the penalty of publishing scurrilous books behind an assumed name or behind their alleged medical character. Curll published a number of quack or alleged medical books among which may be mentioned *The Praise of Drunkenness, The Charitable Surgeon* and *Eunuchism Displayed.* Curll was poisoned with tartar emetic and publicly horsewhipped by Pope; he was kidnaped by the boys of Westminster School and tossed in a blanket with the usual indignities of that procedure, and he stood in the pillory for one hour for his misdeeds. His popularity with the rabble of London was such that the only one to throw a missile at him was roughly handled by the crowd. The militant followers of literature were more drastic in their treatment of their quacks than were the doctors and the dupes of medical charlatans, who could hide the errors and fatalities resulting from their quackery behind the influence of the peccant humors of the body, of demons, the stars, the devil or even of the wrath of God.

The medical quacks made a good living out of rich and poor alike in unacknowledged competition with the regular profession who were governed by the Royal

From a print by Rowlandson, in Author's Collection

Figure XVI

COLLEGE OF PHYSICIANS

College of Physicians. During one hundred and forty years (1682-1823) five successive presidents of this institution—Radcliffe, Mead, Askew, Pitcairne and Baillie—practiced the best of medicine of their time, and carried on their daily visits, almost as a badge of office, the famous gold-headed cane which is now one of the historical treasures of that College, while London was infested by a series of ignorant charlatans who worried a living out of the credulous and unwary.

A law to control quackery was passed in 1511 in the reign of Henry VIII because "common artificers as smiths, weavers and women boldly and accustomably take upon them great cures and things of great difficulty in which they partly use sorcery and witchcraft, partly apply such medicines unto the disease as to be noxious and nothing meet." In spite of the founding of the College of Physicians in 1518 with power to control the growth of this menace to health the number of quacks increased and at the end of the reign of Elizabeth the list of those practicing quackery was described by a contemporary as including "shifting and outcast Pettifoggers, Trasonical Chymists, lightheaded and trivial Druggers and Apothecaries, sun-shunning nightbirds and corner creepers, dull-pated and base Mechanicks, Stage players, Juglers, Pedlers, Prittle-prattling barbers, filthie Crosiers, curious bath Keepers, common shifters, cogging cavaliers, lazy clowns, toothless and tatling old wives, chattering charwomen, long-tongued midwives, Dog leeches and suchlike baggage. In the next ranks follow the Poysoners, Inchanters, Soothsayers, Wizards, Fortune-tellers, Magitians,

Witches, Hags and a rablement of that damnable crew." The writer refers to them all as ignorant, "meere dolts, idiots and buzzards."

Advertising was, and still is, the main support of the ordinary charlatan. In the time of the Tudors and Stuarts the issuing of handbills, laudatory of the author or his methods and of his cures, was the method in vogue. The bills usually gave exact directions how to find the residence and business address which were frequently used by one fraud after another. One such house is described in a bill of Tom Saffold's, "The Black Ball and old Lillys Head next to the Feather Shops that are within Black Friars Gateway which is over against Ludgate Church just by Ludgate in London." This Saffold advertised in doggerel verse:

"Its Saffold's Pills much better than the rest
Deservedly have gained the name of Best
In curing by the Cause quite purging out
Of Scurvy, French Pox, Agues, Stone and Gout,
The head, Stomach, Belly and the Reins they
Will cleanse and cure while you may work or play."

Saffold, ill, would see no physician and take no pill but his own and promptly died in 1691, which fact was announced by the publishing of a ballad in his own style:

"Your oracle is silent none can tell
On whom his Astrologick mantle fell
For he when sick refused all Doctors' aid
And only to his Pills devotion paid
Yet it was surely a most sad disaster
The *Sawcy Pills* at last should *Kill Their Master.*"

The business was carried on at once in the same house renovated by gilding the Black Ball.

"At the Golden Ball and Lillies Head
John Case yet lives though Saffold's dead."

The stories of these two, Saffold and Case, were characteristic of the quack in the seventeenth century who advertised cures of every and any disease. It was customary to advertise their cures to contain rare drugs and remedies, including such costly articles as pearls, gold, the horn of the mythical unicorn and newly discovered chemicals. They were especially free with emetics and purgatives so that their customers got rid of something for their money. One "alchemical philosopher" put his faith in the sulphur, salt and mercury of Paracelsus, others in Persian Balsam to cure corrosive humors in the blood, in Asian Balm or American Essence which keeps the Americans free from gout. Others peddled a Japan powder to expel all manner of worms; a Chinese antidote for rheumatism, or a Turkish, Grecian and Arabian antidote to prevent fainting or the "ptisick," or an elixir of balm of Gilead to renew youth. Many of these "travelled physitians" were foreigners who removed cataract and blindness and set up as stone and rupture cutters. All extracted teeth and many furnished artificial teeth of ivory, silver or gold. Scurvy, which was a common disease, and probably other conditions were often treated under that diagnosis with an herb called Scurvy Grass in Elixir, spirit or pill. The scurvy quack had a mission all his own. During the epidemic of the plague quacks flourished as never before

with alleged specifics of "fumigations," "never failing pills," "effectual pills," "health bringing pills" and other catch-pennies. When the newly discovered cinchona or Jesuit's bark and ipecacuanha were brought from Peru a new crop of charlatans exploited them. New quacks followed old ones, and all seem to have made a living in spite of abuse and ridicule by one another and by the wits of London. In order to attract some ailing person to himself one quack warns against his fellow thus:

"Beware of quacks, Mercury and all such Foes
Lest need ye require a supplemental Nose!"

The following sarcasm was published in 1655 as a description of the medical faker of the period:

"I can make your beauty and preserve it,
Rectifie your body and maintain it,
Clarifie your blood, surfle your cheeks, perfume
Your skin, tincture your hair, enliven your eye,
Heighten your appetite; and as for jellies
Dentifrizes, dyets, mineral fricaseas
Pomatines, fumes, Italian masks to sleep in
Either to moisten or dry the superfices—
Faugh!
Galen was a goose and Paracelsus a Patch
To Doctor Pulsefeel."

But there were greater successes to be won by the advertising quack. William Read began his business career as a tailor. He was a Scotchman who traveled through Ireland and the northern countries and, settling in London, began to distribute printed testimonials as to his skill in couching cataracts and the "cutting off of can-

cerated breasts, mortified arms and legs." In London he advertised himself into the Queen's favor and after being appointed Oculist in Ordinary he was knighted by Queen Anne in 1705, and until his own death was also oculist to George I.

One of the successful financiers among the quacks was Joanna Stephens who treated many for stone in the bladder. When her rich clientele began to drop away from her care, Joanna advertised in the *Gentleman's Magazine* in 1738 that she was ready "to make her medicine publick on consideration of £5000 to be raised by contribution." The subscription rose to some thirteen hundred pounds and was completed by securing from Parliament the whole amount. The formulas were divulged and consisted of a powder of calcined snails and eggshells, also a decoction of some herbs and soap, swine-cress burned to blackness and honey boiled in water, and finally of pills of calcined snails, seeds of wild carrot and burdock, hips and hawes, ashen keys all burned to blackness with alicant soap and honey as the chief ingredients. One of Joanna's most celebrated patients was Sir Robert Walpole who followed the treatment for several years before his death. It was estimated that he had taken one hundred and eighty pounds of soap and twelve hundred gallons of limewater with the result that three stones were found in his bladder at a post-mortem examination.

One of the greatest frauds was perpetrated by James Graham, who fitted up a house in London in magnificence and luxury. This he called the "Temple of Health" where he sold his specifics under the names of Imperial

Pills, Elixir of Life, Electrical Æther and Nervous Ætherial. The Temple contained a "Grand Celestial Bed" in a special apartment which was rented at five hundred guineas a night because in it according to Graham "Children of the most perfect beauty could be begotten." In 1781 Graham enlarged his establishment as a "Temple of Health and Hymen," but failed and died insane in 1794.

One of the frauds fathered by a regular practitioner was known as Perkins' Tractors which have had imitators in more recent times. Elisha Perkins was a physician at the end of the eighteenth century in Norwich, Connecticut, who became enamored with an alleged electrical device to cure illness. He made two pieces of metal about three inches long pointed at one end and rounded at the other. He believed that by wearing one of these between the shoulders and the other on the chest disease would be drawn from the body by the electrical energy generated by the procedure. Perkins claimed that one was made of copper, zinc and gold, and the other of iron, silver and platinum. They probably were pure brass and iron, were sold in London at five guineas the pair, and had quite a vogue both in England and the United States. President Washington took a chance and bought a set, and many others as well, but Doctor Perkins' medical colleagues summoned the inventor before their State Society and when he failed to appear they promptly expelled him by a resolution which accused him of disgraceful practices and stated that his "theories respecting his tractors were delusive quackery." The tractors were finally disposed of

by a Dr. John Haygarth of Bath, England, who got similar cures from tractors made of wood and painted to resemble metal. But Perkins, the son, returned home from London fifty thousand dollars richer than he left it.

For a few years Bishop Berkeley was a resident of Newport, Rhode Island, in the early eighteenth century and is famous as a philosophical writer, who later returned to Ireland and was made Bishop of Cloyne. He became an advocate of Tar water as a cure for all diseases, and was one of the examples of the quack held up to ridicule by Oliver Wendell Holmes alongside Elisha Perkins. Holmes sums up his critical disapprobation both of the Bishop's medical panacea and of his philosophy thus: "He was an illustrious man but he held two very odd opinions: that Tar water was everything and that the whole material universe was nothing." The Bishop did not escape from the scathing criticism of his contemporaries. Sir Charles Hanbury Williams wrote a ballad in part as follows:

"Since good master Prior
The tar water 'squire
  Without being counted to blame
Vulgar patrons have scorn'd
And his treatise adorn'd
  With the luster of Chesterfield's name.

"Then come let us sing
Death a fig for thy sting
  I think we shall serve thee a trick
For the Bishop of Cloyne
Has at last laid a mine
  That will blow up both thee and Old Nick."

This broad satire of the eighteenth century brought out an answer and defense of the learned Bishop:

"No! Stanhope chuses thy abuse.
Detesting such a filthy muse
  Whose very praise is satire
For well he knows the worthless Knight is
Just such another as Thersites
  For bulk, abuse and stature."

William Combe published in 1822 his history of Johnny Quae Genus, the little foundling of Doctor Syntax, and describes the quack of the early nineteenth century for whom Quae Genus works as fake apothecary and service man. The poem is illustrated by Rowlandson who has left us several caricatures of the medical profession.

"I care not by what name you call
This spacious parlour, room or hall:
But here my daily patients range
Whose order you must never change:
Were I to take them one by one,
By Heaven I should ne'er have done:
And, therefore, govern'd by their feather
I thus assort my birds together.
Here, on the right, are duly seated
Those who for gouty freaks are treated,
Then comes the symptomatic fever,
And next the bilious and their liver:
Then follow others in their turn,
The chills which shake, the heats that burn;
The stomachs which will ne'er digest
The food their feeders love the best;
The wheesers too are not far off,
All those who hem and spit and cough.

"Each case that asks superior art.
I send into a room apart;
And *there* I never feel alarm;
I play no tricks and do no harm.
When I a desp'rate illness see,
For patients must not die with me,
I recommend them to repair
To goats-milk and the country air;
And when such counsel they receive
They do not fail to take their leave,
Full of my candour and disdain
Of any little paltry gain.

"—'Tis true 'mong doctors I'm not famous,
But still I'm not an *Ignoramus;*
For I can play a skillfull part
In elements of chymic art;
I give the drafts a varying hue,
To-day so red, to-morrow blue,
And touch them with a diff'rent savour,
To give a worse or better flavour,
As it may suit, then change their name,
Though they may be the very same,
Both in their object and their aim."

Mesmer

Franz Anton Mesmer (1734-1815) was born in Switzerland, graduated in medicine at Vienna in 1771 and wrote a dissertation for graduation on the astrological subject, *The Influence of the Planets and Stars on Man.* He soon developed his leaning toward ideas now known as hypnotic but described by him as "animal magnetism." He published his book in Paris and Geneva in 1779 and settled in Paris where he made a commercial success with his séances in animal magnetism. He

had previously been driven from Vienna, and the Medical Faculty of Paris eventually compelled him to migrate. His ideas were exploited in the Temple of Health at London by the quack, James Graham. Mesmer's treatment undoubtedly resulted in a number of cures in persons who are subject to the mesmeric influence. His name has become a real addition to the language of medicine, although other labels have been placed on the observed facts. Mental suggestion has been studied and under the name of hypnotism has been practiced by many reputable physicians. But the methods have been exploited by dishonest men and by ignorant ones, and harm to the individual has frequently resulted by postponing necessary and urgent medical and surgical relief until the possibility of a real cure has been lost.

The teachings on hypnotism by Bernheim at Nancy in 1880 and in the same city in more recent times those by the clever apothecary, Coué, must be classified as examples of mental suggestion. Patients suffering from illogical processes of the mind may be cured by subconscious hypnosis, but the practitioner must be careful not to overlook the early stages of the development of serious organic diseases of the heart, lungs and kidneys, and of cancer in any organ.

Mesmer grew rich out of proportion to the value of his theories, but it is only fair to say that some of his later followers did not. The wand, the mystic passes of the hand, the fixing of the gazing eyes and the bizarre clothes of lilac hue affected by Mesmer at his group séances possess all the earmarks of the charlatan. He died at eighty-one years of age forgotten by his con-

From a photograph of a painting by Van Hoogstraten in the gallery at Amsterdam, in Collection of Archibald Malloch, M.D.

Figure XVII

PHYSICIAN OF THE SEVENTEENTH CENTURY

temporaries. Mesmer was the type of a more or less honest but self-deluded crank who, though well educated as a physician in the best of universities under the leading teachers of his time, nevertheless wandered from the paths of truth and science into the vagaries of mysticism and the astrology of a past generation. He believed in the existence and verity of his theories of animal magnetism as a manifestation of electrical or magnetic forces. He could not be persuaded of his errors even after the disapproval of his results following the investigation of his methods by the commission appointed by the Medical Faculty of Paris of which Baillie, the English clinician, Lavoisier, the chemist, and Franklin, the American, were prominent members.

Cagliostro

It was quite another character, a quack pure and simple, who paraded about Europe as the great exponent of the mysteries of Egypt and the East under the name of Count Alessandro di Cagliostro. Cagliostro was born in 1743 in Palermo as Giuseppe or Beppo Balsamo and began to study for the priesthood. He was driven from his monastery for irregularities, and returning to Palermo was soon on his way in a forced and involuntary exile for the eastern coast of the Mediterranean Sea. He traveled far in many countries of western Asia and eastern Europe and learned the superficial methods of Swedenborgian magicians, Illuminati, Rosicrucians and other brands of secret societies.

On his return to western Europe he began a career of cheating and living by his wits which led him to all capitals. In London he was associated with James Graham and his house of health, but left to save himself from English law and justice. From London he wandered to Leipzig and Petersburg, and from Berlin back to Paris where he ran foul of the police for the last time in the affair of the Diamond Necklace and entered the Bastille. He was freed and turned homeward to Palermo, was discovered by the Holy Inquisition and imprisoned in 1791 in the Castle of St. Angelo at Rome as a heretic. He finally died in the prison of St. Leo in 1795.

This greatest of quacks beat a living for forty years out of the élite of Europe by selling chairs to cure rheumatism, powder to make women beautiful, love-charms, beds to insure painless childbirth and a cantharidal elixir of life. He was a born liar without one grain of moral sense in his make-up. Thomas Carlyle wrote an essay on his life and sums up his character thus: "Count Alessandro di Cagliostro, Pupil of the Sage Althotas, Foster Child of the Scheriff of Mecca, probable son of the last King of Trebizand; named also Acharat and Unfortunate Child of Nature; by profession healer of diseases, abolisher of wrinkles, friend of the poor and impotent Grand Master of the Egyptian Mason Lodge of High Science, Spirit Summoner, Gold Coak, Grand Cophta Prophet, Priest and thaumaturgic Moralist and Swindler and what one may call the King of Liars."

Gall

A large four-volume treatise on the anatomy and physiology of the nervous system was printed at Paris in 1810-1819 by Franz Joseph Gall and Johann Gaspar Spurzheim. This contained a scientific presentation of the knowledge of the day on the chosen subject. But hidden in the volume the new science of phrenology was exploited as the last word in the science of cerebral localization. The craniology of Gall became later the phrenology of Spurzheim and led to all kinds of absurdities. This new science claimed that the brain contained thirty-seven separate centers of function which could be mapped out and their relative development measured by the elevations and depressions on the exterior surface of the skull. Gall, like Mesmer, was banished by professional ostracism from Vienna and died rich in Paris as did his contemporary, Hahnemann. Phrenology was exploded by the demonstration that knobs on the skull often had similar thickenings on the interior and therefore relative depressions in the brain. This science degenerated, at least in the United States, to being exploited by the traveling "professors" and quacks at country fairs in association with the demonstrations of the antics induced by the administration of laughing gas before that useful chemical was recognized as a valuable drug in surgical anesthesia. The former popular interest in the bumps of combativeness, secretiveness, acquisitiveness, philoprogenitiveness and similar human characteristics is no longer heard of. The present generation has arrived at the latest landmark in

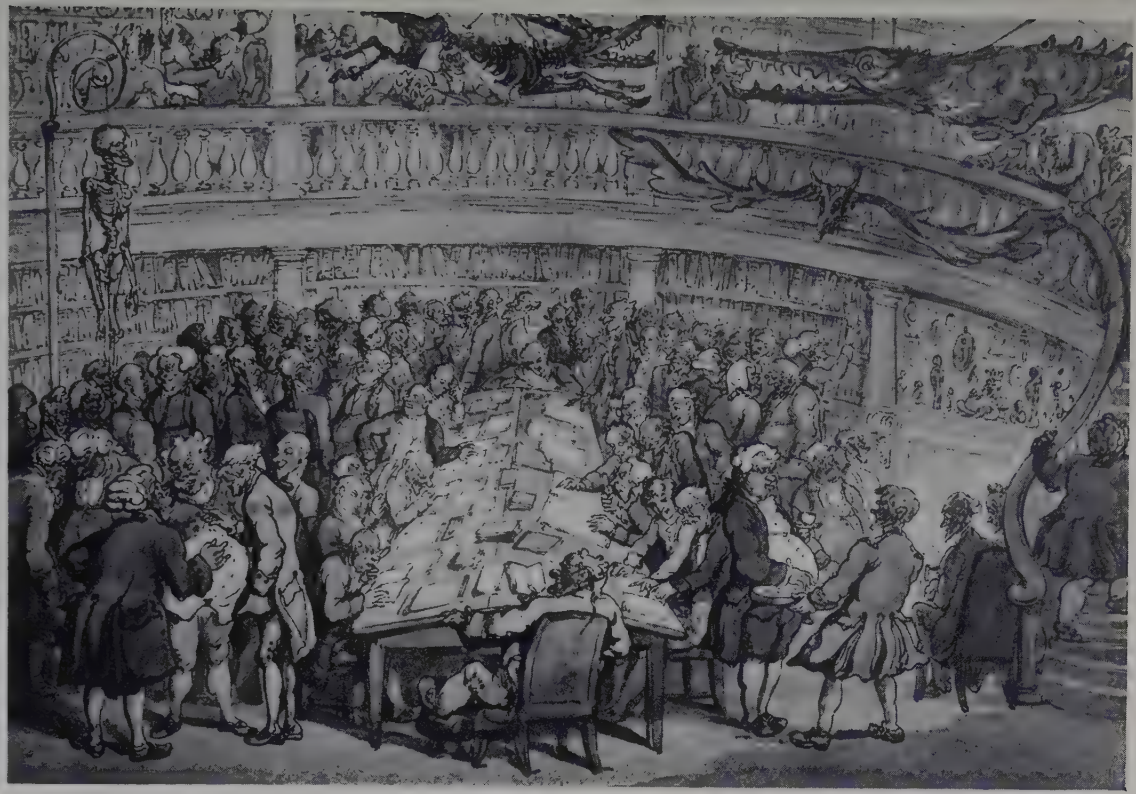
the development of the race and its civilization: the exploitation of sex and its problems.

Both the regular profession and the quacks have been subjected to portraiture by contemporary artists and to critical attacks at the hands of the caricaturist. This was especially true in the seventeeth century. Many small paintings of a physician visiting his patient were painted by von Mieris, Gerard Dou, Teniers and others. One such by von Hoogstraten has been reproduced for this volume and presents the general dress and appearance of the practitioner of the seventeenth century, his emphasis on the superficial observation of specimens and his lack of any modern conception of the examination of a patient. (Figure 17.)

Gilray and Rowlandson were prominent in England as critical portrayers of the foibles of the physician. Rowlandson's cartoons of the *College of Physicians* and of a *Conversatzione at the Hall of Surgeons at the Old Bailey* are dated about the year 1800. (Figures 16 and 18.)

Modern Charlatanism

The development of modern medicine upon the logical and firm basis of scientific investigation and experiment goes on steadily, but the human mind will still follow the promises and seductive claims of successful cures which are put forward by any individual charlatan. Father Knipe or his followers still persuade people who may trust him that walking with bare feet on the grass at sunrise is a sure cure of bodily ills. Some other exponent of a foreign religion perhaps from the East may



From a water-color drawing by Rowlandson, in Author's Collection

Figure XVIII

CONVERSATZIONE AT SURGEONS HALL

advise his trusting applicant for health that standing on the head for certain periods of time may have a similar effect. And strange to say, in the cases of fatigued and emaciated persons, especially women, good may follow this particular practice. The cures by manipulation, which are known as chiropractic and other forms of massage will have of course some beneficial effect upon a limited number of patients. The objection to all this form of treatment is not that it is useless, but that its application is limited and it becomes a fraud when extravagant claims are made and when the laws regulating the practice of medical art are not enforced against the absurd application of these methods to the universal treatment of any and all diseases.

It is difficult to know whether to consider the organization known as Christian Science as a religion or a school of medical treatment. As a religion it is not for a physician to question either the honesty of its practitioners or the truth of their claims. As a method of cure of universal application too much can not be said against it. As an appeal for the control of the emotions of the morbid imagination of introspective neuroses, which may be causative in developing all kinds of discomforts and pains, Christian Science may have a field to remove worries over conditions which have no existence in fact, to relieve suffering which is mental and not physical although it is assumed to be due to organic disease. But when a Christian Science healer attempts to control a growth of cancer or undertakes the treatment of fractured bones without proper readjustment and alignment, or to dissipate internal ab-

scesses due to a ruptured appendix, it is time to call a halt.

Every physician has seen death brought about by the delay of treating diseases which might have been cured under proper and prompt methods of relief. Death from diphtheria without the use of antitoxin, from strangulation of a rupture without mechanical relief and from similar causes are far too common to pass over without remark. It may be that it is legal for any man or woman of alleged sanity to neglect their own diseases and commit medical suicide by leaning upon Christian Science or New Thought or any of the other emotional appeals tending to cause forgetfulness of warning symptoms of disease, but the State by a prompt and efficient administration of regulating laws should insist that the lives of little children should not be risked by a withholding of proper medical care even when refused by their own parents. A break in the ranks of Christian Science has appeared, and the Mother Church and the Parent Church are now at loggerheads over the desirability of calling in the doctor. The future will decide the final result to a medical profession waiting with curiosity as the prominent attitude of mind.

To-day there are other and more insidious forms of charlatanism being put into practice. The theories on which psychoanalysis is based unquestionably have a foundation in fact. But those members of the profession who make a specialty of this comparatively narrow field tend to give it a wider application than is warranted by any facts which have been proved concerning it. Hidden sources of many mental processes

unrecognized by the individual undoubtedly exist, but this fact is no reason for the extreme significance placed upon the interpretation of dreams, absent-minded actions, subconscious memories and neuroses of anxiety and fear which has become associated with the modern cult of psychoanalysis. In the hands of the dishonest charlatan the practice of cures by suggestion and psychoanalysis is a real menace to the health and happiness of any trusting victim.

What promised to be a more or less dangerous fad swept over the United States a few years ago. It originated in the brain of a physician of California named Abrams, and had to do with the assumed vibrations emanating from the tissues and fluids of the body. By means of an electric device Abrams claimed that he could diagnosticate disease from a drop of blood sent from any patient. The details of the method are not worth repeating for the Abrams cult ended coincidently with the death of its inventor, and Abrams' machine, the oscilloclast, will probably not be heard of again. Its course was one of rapid growth and development, and its results when tested by physicians even in the hands of Abrams himself showed as many failures as would result from pure guessing except in those cases where a leakage as to diagnosis occurred. The method had such a short duration that its history turned out a comedy which rose above the low level of ordinary life as a brilliant rocket and came down just as quickly, a mere stick.

There still exists an ancient fraud which is perpetrated both on the general public and on the unthink-

scopic structure of tissues. He occupied the position of professor of anatomy at the University of Bologna, and became physician to the Pope. A man of attractive personality, warm-hearted and sympathetic, he became a successful practitioner, was an indefatigable worker and constructed his own microscope. He made careful, painstaking and accurate observations of all that his microscope revealed.

It has been mentioned already that Malpighi demonstrated in a frog's mesentery a fine network of microscopic blood-vessels through which he could see the blood corpuscles moving. Through these fine blood-vessels the blood passes from the arteries to the veins, and begins its return journey to the heart. Malpighi's name is preserved in histological nomenclature by the names of the Malpighian bodies in the kidneys which consist of a tuft of fine blood-vessels surrounded by a tubule into which water and waste products are collected from the blood to be excreted by the kidneys, by the Malpighian corpuscles in the spleen and by a layer of the skin called the rete Malpighi. He showed that the trachea, or windpipe, divided into bronchi which underwent finer and finer divisions until they terminated in minute hollow cells which were surrounded by a rich network of blood-vessels, and that here the inspired air and the blood were separated only by fine membranes. In addition, he contributed to the knowledge of the structure of other organs, especially of the liver and spleen, described the red blood corpuscles and did pioneer work in microscopic embryology. In his private life Malpighi was rendered unhappy by his inheritance

From a photographic reproduction in the Collection of The New York Academy of Medicine

Figure XIX

VAN LEEUWENHOEK

of an old family feud which resulted in the loss of some of his valuable notes, and by bitter attacks upon him by Borelli, a jealous colleague. Malpighi died in 1694.

Antonius van Leeuwenhoek

Antonius van Leeuwenhoek was born in Delft in 1632. He inherited moderate means, and was not a physician, nor did he have any regular profession or occupation. Possessed of a great deal of mechanical genius, he ground the lenses for the microscopes which he constructed. These microscopes were far superior to those generally in use at the time. In all he constructed over two hundred of them, twenty-six of which he presented to the Royal Society in England. His portrait shows a richly dressed man of means with the tools of his scientific avocation at hand, including one of his small microscopes which in his own hands as well as in those of trained physicians gave an impetus to the newly developing sciences of biology and medicine. (Figure 19.) With these microscopes van Leeuwenhoek searched and investigated everything that came to his hand, writing about and describing everything that he saw. He examined drops of stagnant water, and found them to contain numerous minute living things or animalcules not visible to the naked eye; he saw and gave accurate descriptions of the red blood corpuscles and confirmed the observations of Malpighi of the circulation of the blood in the capillaries. Perhaps his most important observation was that of the four types of bacteria which he found by taking scrapings from his own teeth. In this

way he described the round dotlike bacterium (coccus) occurring in lines or chains (streptococcus) and in clusters (staphylococcus), the threadlike bacterium (bacillus) and the spiral or corkscrew-shaped bacterium (spirillum). While van Leeuwenhoek recognized these bodies, their significance was not explained until Pasteur's work over a century later.

Van Leeuwenhoek always tried to be painstakingly accurate in his observations and descriptions and was always ready to admit the possibility of error. He was sometimes secretive about his technical methods, and sometimes exhibited jealousy of others engaged in the same field of work. During his lifetime he was regarded with great respect by other scientists and was elected a member of many scientific societies, among them the Royal Society of England. He died in 1723.

Giovanni Battista Morgagni

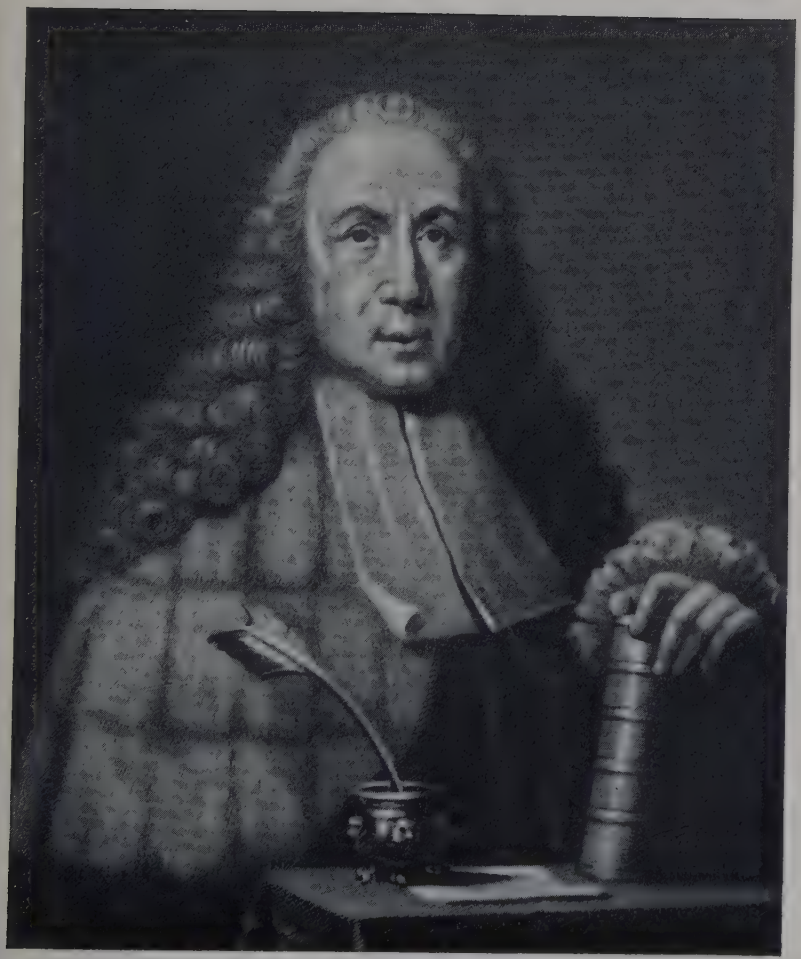
The discovery of the microscope led directly to the study of the causes of disease as found by examination of the body after death. The first and one of the greatest students in this branch of medicine is Giovanni Battista Morgagni who was born at Forli in Italy in 1682, and died in 1771, his ninetieth year. Morgagni held the chair of Professor of Anatomy at Padua for sixty years. He studied as a younger man under the anatomist, Valsalva, at Bologna, for whom he served as prosector and demonstrator of anatomy. His principle work, *De Sedibus et Causis Morborum,* was published in Venice in 1761 when he was eighty years of age, and

was republished many times during the following sixty years. Morgagni presents in these two large volumes the results of his observations made at the autopsy table. The whole field of pathology is covered, and the general purpose of correlating the findings in the body after death with the symptoms and conditions observed during the life of the patient is detailed. An attempt is made to associate individual symptoms with the anatomical conditions found. The book is not a modern treatise on pathology but a citation of various cases and of individual observations made by the author describing the pathological anatomy of a disease in association with its symptoms and also its treatment. Morgagni's influence in medicine was carried on through many pupils who came to Padua to see and hear him, and his influence extended in this way to the whole of Europe. His most celebrated pupil was Antonio Scarpa (1747-1832) who became well-known as anatomist and surgeon. Morgagni's portrait presents the formal dress and wig of the early eighteenth century (Figure 20), and that of his scientific successor, Bichat, shows the more natural and less artificial appearance of the physician of the end of that century. (Figure 21.)

Marie François Xavier Bichat

In the year that Morgagni died Marie François Xavier Bichat (1771-1802) was born at Thoirette, France. He was the son of a physician and studied medicine at Montpellier. Bichat moved to Paris and became associated with the Hôtel Dieu. He was active

in surgery and experimental physiology though his greatest achievements were in gross pathological anatomy. In association with Desault, a surgeon, he was one of the founders of the French School at Paris which took the first rank in medicine during the early nineteenth century. Bichat took great interest in philosophical theories. Distinctly a vitalist, he followed the teaching of von Haller and his theories of sensibility and contractility. He considered life as a grouping of functions which were continually struggling against death. Bichat's real contribution to medicine is found in two books, *Le Traité des Membranes en Générale,* published in Paris in 1800, and his *Anatomie Générale Appliquée a la Physiologie et a la Médicine,* published in Paris in 1801. Both treatises consider the development and structure of the human body in relation to different ages and to pathological conditions due to disease. Bichat laid particular stress upon the fact that every organ and every structure in the body could show evidence of disease in itself, that the pathological changes due to disease were of similar nature no matter which organ was involved, and that the symptoms of the disease were in direct relationship with the pathological changes. In this way he established the study of the individual tissues of the body and placed the science of macroscopical pathology on a firm basis. His work is distinctly that of a pathological anatomist for, although he discusses therapeutics, he can not offer any particular method of treatment beyond the choice of remedies according to the Brunonian classification into sthenic and asthenic remedies. Bichat, who was an indefatigable



From an engraving by W. Holl in Pettigrew's MEDICAL PORTRAIT GALLERY, in the Collection of The New York Academy of Medicine

Figure XX

MORGAGNI

worker, died of a severe fever in the thirty-first year of his life.

Louis, Cruveilhier, Bouillaud, Potain

The methods of Morgagni in combining the study of the symptoms of a disease at the bedside with the pathological findings in the body in fatal cases led Pierre Charles Alexandre Louis (1787-1872) to differentiate one group of cases from the group of fevers known as putrid fever. Louis completed this important contribution to medicine in 1827 and named the newly described disease typhoid fever. His pathological work also added much to the understanding of various forms of tuberculosis. Louis introduced also the statistical method of studying medical problems. A remedy frequently becomes popular in a given condition because patients who have used it have recovered. Physicians and the laity often forget the Hippocratic dictum, that in many diseases nature unaided works a cure and that the remedy used gains undeserved credit. In the time of Louis, bleeding was the almost universal remedy applied in pneumonia. Louis proved by statistics that as many people recovered from pneumonia who were not bled as did those who were, and helped to correct the prevalent opinion favoring phlebotomy. His opposition to phlebotomy brought down on him the anger of the brilliant but prejudiced Broussais who described Louis's book, *Recherches anatomico-pathologiques sur la phthisie,* as a lifeless work breathing fatalism, forgetfulness and death.

To this same Anatomo-Pathological School of Paris one must add Jean Cruveilhier (1791-1874) whose methods were those of Morgagni and whose beautiful Atlas appeared in folio from time to time (1828-1842). He added gastric ulcer to the list of diseases with an exact pathology. Jean Bouillaud (1796-1881) was another of the French clinical pathologists who, with his pupil, Potain (1825-1901), increased the knowledge of acute and chronic heart disease and its relation to rheumatism. These students of clinico-pathological anatomy held the School of Paris in the front rank for nearly a century.

Johannes Müller

The father of German medicine was Johannes Müller (1801-1858), one of those intense spirits of great intellectual endowment who interested himself in all branches of medicine and the allied sciences. He resembled John Hunter in that he was a great naturalist, and while Hunter did pioneer work in comparative anatomy, Müller was one of the first comparative physiologists. His list of contributions to medicine is a long one, embracing important additions to the sciences of physiology, embryology, psychology and pathology. In the early part of his career he published his great text-book on physiology. Among his other contributions to medicine are his work on the functions of the retina; in embryology his identification of the two ducts which develop into the female generative organs—Müller's ducts; and in pathology his con-

tributions to the clarification of the nature of tumors. Müller had an attractive magnetic personality. In his early years he conducted many experiments upon himself. It is said that by practicing before a mirror he came to be able to dilate and contract his pupils at will. As the result of his self-study he had a nervous breakdown when he was about thirty which resulted in an enforced rest after which he was careful to avoid further self-observation. As a teacher Müller inspired many students who achieved distinction. Among these were: Theodor Schwann (1810-1882) who introduced the cell theory or doctrine that all organic matter consists of cells or microscopic units, and that the activity of these cells forms the essential process of life; and also Jakob Henle (1809-1885), the famous anatomist successively professor of anatomy at Zurich, Heidelberg and Göttingen, who first described epithelial cells, or the cells which line all the surfaces, tubes and cavities of the body, and who made many original anatomical discoveries. Because of his rare charm, Henle was a favorite of Müller and the idol of his students and colleagues. The physiologist, Du Bois Reymond, and the histologists, von Kölliker and Virchow, were also pupils of Müller.

Rudolf Virchow

The next great advance in the study of pathology came from Germany at the hands of Rudolf Virchow who applied the discovery of the vegetable cell by Schleiden and that of the animal cell by Schwann to human

anatomy and pathology. This ultimate subdivision of living tissue into individual cells marked an entirely new departure concerning the structure of animals and of plants, both as to growth and development, and regarding the changes in various organs caused by disease. The whole theory of cellular pathology rests upon the aphorism pronounced by Virchow: *Omnis cellula e cellula.* Rudolf Virchow was born at Schievelbein in 1821, graduated in medicine in 1843 and became prosector for Froriep at the Hospital Charité in Berlin. He was dismissed from Berlin in 1849 because of his political democracy but was called to the chair of pathological anatomy at Würzburg in Bavaria. Because of his brilliant work and publications he was recalled to Berlin in 1856 and remained professor of pathology at that university until his death in 1902. Virchow took a leading part in the government of Germany and was a member of the Reichstag for thirteen years, during which time he always supported the rights of the people. His work in sanitation brought about a new sewerage system for Berlin, and his reputation became world-wide. Just before his death a new municipal hospital was named for him, and opened in January, 1902. Rudolf Virchow was the typical scientist of the rising German school of medicine in which he held the center of the stage for the third quarter of the nineteenth century. (Figure 22.) He published his book on cellular pathology in 1858. This conception of the structure of the body gave a different meaning to the effects of inflammation and other pathological changes, and showed that the essential changes of diseased tissues were modi-

From an engraving by H. Cook in Pettigrew's MEDICAL PORTRAIT GALLERY, in the Collection of The New York Academy of Medicine

Figure XXI

BICHAT

fications of the normal cells of the body and not an invasion of extraneous cellular organisms.

Cellular pathology presented new solutions of the pathological processes associated with disease and infections and has fitted in logically with the later discoveries of Pasteur and the bacteriologists. Virchow's mind was one of comprehensive conviction and placed him among the great medical philosophers, for he did not hesitate to formulate the logical conclusions to which his theory led. He explained the beginning of inflammations by adding to the theory of irritation originally proposed by Brown and Broussais the idea that phlebitis of small vessels would result in the formation of small thrombi which could be carried in the circulation and cause embolism at any distant point. These capillary emboli could then set up new inflammatory processes. The discovery of bacteria has only added to the theory the conception that the bacteria themselves form the causative element in the embolic mass. The same theory of extension by embolism from migration of the cells of tumors is used to explain the metastatic development of cancers and other malignant growths. Johannes Müller had already suggested that the development of cells in the embryo could teach us the nature of the increase of cells in pathological inflammation. The formation of tubercles in tuberculosis before the discovery of bacteria and their relation to disease was thought to be analogous to the growth of malignant tumors and is explained to-day on the same theory of embolism.

In 1897 at the age of seventy-six Virchow, who was

a vitalist in the conception of the nature of man, formulated his scientific philosophy and communicated to the Medical Congress in Moscow his theory of the continuity of life which he believed should be an article of the faith of every physician. He denied that life could proceed from any source except that of a previous living cell although he admitted that conditions might have been different at some other time. He claimed that one could not conceive of any other theory of life. No disease could exist, no new growth could occur except that it proceed from a previous cell. The growth of inflammatory or tumor tissue occurs only under the influence of an irritation whether that be due to bacteria or to some other toxic cause. He made the microscope a means by which man could study and recognize the hereditary nature of every cell from its parent cell in successive generation, and he endorsed the theory of Charles Darwin in that it owed its appeal and acceptance to no other theory than the continuity of life of the cell applied to complex organisms.

Claude Bernard

Paralleling the life and activity of Virchow, Claude Bernard (1813-1878) was working in the physiological laboratory and placing experimental physiology on the list of leading biological sciences. Bernard took a deep interest in the theories of medicine and laid down his philosophy that the laboratory held the key to the mysteries of life. As Virchow depended on the microscope and the living cell, Bernard put all his faith in

From an unsigned engraving in the Collection of The New York Academy of Medicine

Figure XXII

VIRCHOW

physiological experiment. In 1865 he published his *Introduction à l'étude de la Médicine expérimentale* in which he formulated the rules of procedure demanded by his science. He also was a vitalist, but he considered science to be above all theoretical systems of philosophy, that it must work with the phenomena developed in experiment and take no note of the original causes of life. Claude Bernard considered the questions of solidism, humoralism, organicism, animism or vitalism as having nothing to do with physiological investigation. The attitude of the experimenter must not be that of the skeptic who doubts the facts developed by his science and transfers his faith only to himself. He must, however, have a scientific doubt not in his science but in his own methods of procedure and question his own results and the causes of his possible errors, yet he must believe that the scientific principles and laws are fixed and determined. Claude Bernard believed in the laboratory as the true source of explanation of all the facts of medicine. He designates it as the true sanctuary of medical science and places clinical medicine and the hospital as subsidiary and only the vestibule of the structure. His discoveries, important and giving a distinct èclat to the medicine of France, were: the existence of vasomotor nerves, the digestion of fats by the pancreatic juice, the poisoning of the blood by carbon dioxide, the relation of the brain to the excretion of sugar and of the liver to the digestion of carbohydrates.

XII

AUENBRUGGER AND LAENNEC

The Development of Differential Diagnosis

One of the landmarks which distinguishes the beginning of modern medicine is the discovery and introduction of methods of precision in diagnosis. Joseph Leopold Auenbrugger, born in Gratz, Austria, in 1722, is the author of the method of investigating the condition of the viscera contained in the chest by the character of the sound elicited when the chest is struck,—that is, by percussion. It seems strange that until the eighteenth century no one had advanced this procedure as a method of diagnosis. As in the case of so many discoveries, percussion seems an obvious and simple method of examination after some one has already drawn attention to it. In medicine as in other sciences seemingly simple facts have always had a way of concealing themselves from the human mind until grasped by some genius. The fundamental elusiveness of these facts even for the genius is illustrated by the fact that while Auenbrugger found a great deal revealed to him by the note elicited in tapping the chest he did not avail himself of the additional knowledge which would have come to him by listening to the chest with his ear,—auscultation. Fifty years later Laennec was to introduce this method of diagnosis.

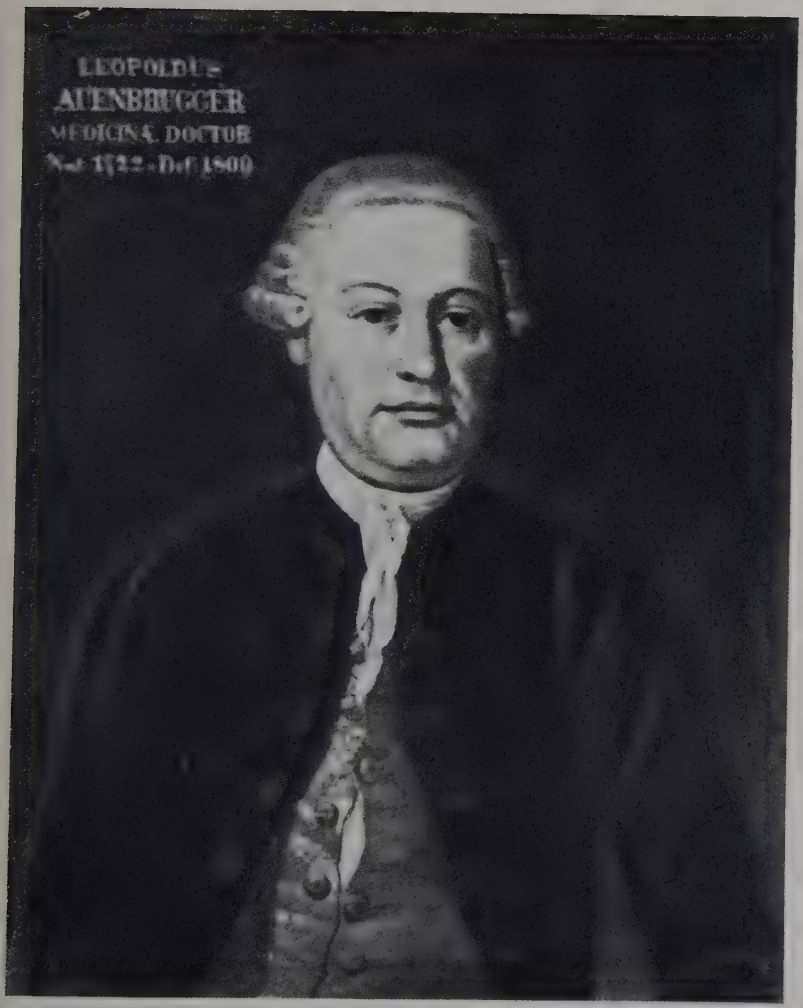
The father of Auenbrugger was a prosperous inn-

keeper who succeeded in giving his son a medical education at Vienna. Auenbrugger, a lovable, conscientious and sympathetic character for whom people quickly formed a liking, was accepted and became a favorite with the cultured circles in Vienna. Auenbrugger was a late contemporary of Morgagni and dressed in the earlier mode of his era. (Figure 23.) A caricature of the physicians of the eighteenth century is found in the drawing, known as *Consultation des Medicins,* by Boilly, who in 1760 showed the bewigged medical men of his time discussing a diagnosis with every indication of human interest and energy. (Figure 24.) At twenty-nine he was appointed physician to the Spanish Military Hospital. Here he began his observations on percussion of the chest and had frequent opportunity to correlate his findings with conditions found at autopsy. After seven years of industrious research he published his little book of about ten thousand words entitled *Inventum Novum* or *A New Discovery That Enables the Physician from the Percussion of the Human Thorax to Detect the Diseases Hidden within the Chest.* This little book of ninety-five pages was printed at Vienna in 1761, by John Thomas Truttner.

In this book Auenbrugger points out that the healthy chest when struck gives out a note which sounds like the note given by a drum covered with a woolen cloth. To obtain the note satisfactorily the physician should cover the chest with a cloth or wear a glove of unpolished leather, and strike the chest slowly and gently with fingers flexed on the hand and their tips together. He maps out the areas on the chest wall where this note is to

be obtained normally, and shows that over the heart the note becomes dull as it does over the lower right chest in front and at the side because of the underlying liver. He shows that in disease of the lungs the normal note changes to dull over the affected area, and that the extent of the area of the changed note is commensurate with the underlying disease. After this he goes on to describe the note as it occurs in various conditions, such as an effusion of fluid into the chest, or in the formation of cavities in the lung. Auenbrugger had a very plentiful supply of material for his study because of the great prevalence of tuberculosis in Vienna in his day. In his book he does not speak of tuberculosis as a disease but speaks of the pathologic changes which he found in the lungs on post-mortem examination. He cites the frequency with which he found these changes in cases of melancholia, remarking that homesick recruits were particularly prone to them, and that with the reduction of the period of military training the condition had become less frequent. Humanity has gained by Auenbrugger's discovery in the treatment of all chest conditions and has reaped the greatest benefit in its relation to tuberculosis. The reduction in mortality from tuberculosis of the present day rests largely on the early diagnosis of the disease, and percussion aids the physician in making this diagnosis.

Auenbrugger's book received scant attention from his contemporaries. Van Swieten and de Haen, Professors of Medicine at Vienna who had been pupils of Boerhaave and had helped to found the Vienna School, ignored Auenbrugger's work entirely. Auenbrugger



From a reproduction of a portrait in the Collection of The New York Academy of Medicine

Figure XXIII

AUENBRUGGER

gave way to no futile resentments at the reception his book received but went on his way with calm conviction of the truth and usefulness of his work. He became a busy practitioner always ready to obey the calls of the sick, and much in demand as a consultant in diseases of the chest. He became a favorite at Court and found great diversion in music. He wrote a light opera, *The Chimney Sweep,* which became very popular. When the Empress Maria Theresa asked him why he did not write another opera he replied that he had other things to do, and that "one was enough." He was knighted by the Empress not because of his contributions to medicine but because of his personal popularity.

Corvisart

Forty-seven years after its publication Corvisart, Napoleon's able physician and a leader of medicine in Paris, translated the *Inventum Novum* and gave it generous praise. At this time, a year before Auenbrugger's death at the age of eighty-seven, percussion began to come into its own. Jean Nicholas Corvisart (1755-1821) exercised a strong and beneficent influence over French medicine, introduced percussion in France and was an inspiring teacher, among whose pupils was the illustrious Laennec. He was the author of an important text-book on diseases of the heart. In 1828 Piorry was a pioneer in the introduction of the present method of percussion by tapping either with a small hammer on a piece of ivory placed on the chest wall or with the fingers of one hand upon a finger of the

other placed against the chest rather than upon the chest wall directly. This method is called mediate percussion as distinguished from the direct method of Auenbrugger.

Laennec

Diagnosis by the method of auscultation was introduced by René Théophile Hyacinthe Laennec who was born in Quimper, Brittany, in 1781. Laennec received his medical education at Paris, and after service as an army surgeon was appointed physician to the Hôpital Beaujon and Hôpital Necker in Paris. Laennec said that his attention was drawn to mediate auscultation when consulted by a young woman with symptoms of heart trouble. He was unable to disclose anything abnormal by percussion, and since the patient's age and sex prohibited his applying his ear to her heart, he took a quire of paper, rolled it into a cylinder, applied one end to the patient's heart and the other to his ear. Struck by the intensity with which the heart was heard he immediately began to fashion wooden cylinders on the same pattern which he called stethoscopes.

For the next two years Laennec conducted researches on the sounds heard in normal and abnormal conditions of the heart and lungs. He came to know the sound made by the air in entering and leaving the lungs in healthy persons, and then noted the changes which occurred in these sounds in the various diseases of the lungs. He found it necessary to invent descriptive names for the adventitious sounds, or sounds which he

heard which were not present in the normal chests. He originated the name *râle* for sounds occurring during the inspiratory or expiratory phases of respiration, and he invented the term *ægophony* for the bleating quality of the voice when transmitted through lungs compressed by fluid in the chest. He familiarized himself with the sounds made by the normal heart, and then learned how these sounds were modified by the presence of disease of the various heart valves. These findings he confirmed by post-mortem examinations.

In 1819 he published his book, *Traité de l'Auscultation Médiate,* at Paris. This book immediately excited the interest not only of French physicians but those of other countries. Laennec became well known, and students from all countries came to hear him. He was a most interesting and instructive speaker in all branches of medicine. His contributions to medicine were not confined to the auscultatory method of diagnosis but included original research in pathology. A type of cirrhosis of the liver which he described bears his name,—Laennec's cirrhosis. In addition to his research work and teaching, Laennec cared for a large practice much of which was among the poor. Under the stress and fatigue of so much work his health broke down and he was forced to retire to the country for two years. Upon his return to Paris he resumed his labors. Naturally much of his work both in practice and in the post-mortem room dealt with cases of tuberculosis. After four years Laennec again became ill and developed tuberculosis himself. Just at the time when his work was acquiring its full recognition and appreciation Laennec

died, at the age of forty-five. He was one of the greatest physicians in history, a great benefactor of humanity and a martyr to his calling. With Laennec the nineteenth century was fairly begun and the portraits of physicians no longer take on an unusual appearance because of special gowns and modes of dress, of wigs and artificial means leading to a distinctive appearance of the medical practitioner. The physician of the past hundred years has appeared as any contemporary gentlemen. Laennec is seen as a Parisian of 1820. (Figure 25.)

Auenbrugger and Laennec in this way laid the foundation for the development of a scientific method of diagnosis. From their time on, new means were gradually acquired by which the physician was enabled to form a diagnosis not primarily from the aspect of the patient and his subjective complaints but from the physician's own objective findings. This art of physical diagnosis at first centered upon the diseases of the chest, but it was soon extended to other parts of the body, and percussion, palpation and auscultation are now just as much a part of diagnosis of abdominal diseases as of chest diseases. How extensive a knowledge Hippocrates and his followers had of this art of physical examination is not known. That he practiced some forms of it is recorded in the Hippocratic writings, and, as already pointed out, he described the friction sounds caused by adhesions between the lung and the chest wall, and the splashing sound caused by the presence of fluid and gas in the pleural cavity, and he mentions as symptoms of the diseases which he describes enlargement of the liver and of the spleen. Hippocrates knew that the

From a colored print by Boilly, dated 1760, in Author's Collection

Figure XXIV

CONSULTATION DES MEDICINS

spleen enlarged in certain infections, and this symptom is still a prominent factor in the diagnosis of typhoid and malarial fevers.

Graves, Stokes and Corrigan

The great Irish physicians of the early nineteenth century, Graves, Stokes and Corrigan, made lasting improvements on the art of diagnosis. Robert James Graves (1796-1853) instituted reforms in medical teaching in Dublin and gave original descriptions of several diseases. The best known of these was his description of exophthalmic goiter which still bears his name,—Graves' disease. Graves was a highly cultured gentleman who painted as a diversion, and was so able a linguist that he was arrested when a young man in Austria as a German spy because the authorities insisted that no foreigner could speak the language so well. Graves' contemporary and colleague was William Stokes (1804-1878), who quickly adopted Laennec's method of auscultation and became an authority on diseases of the chest. His name is coupled with that of his countryman, Adams, in Stokes-Adams disease,—a condition in which the impulse of contraction is blocked between the auricles and ventricles of the heart; the ventricles as a consequence beat very slowly often with resultant loss of consciousness. Stokes used the influence which his reputation gave him for improving the condition of his more humble professional brethren, and obtaining just compensation for their work among the poor during times of epidemics. Sir Dominic Corri-

gan made a study of diseases of the heart valves. He pointed out that in diseases of the aortic valves, in which these valves become deformed and allow regurgitation of blood from the aorta into the heart, the pulse has a peculiar water-hammer quality. This type of pulse is known as the Corrigan pulse.

Bright and Addison

Among other contributors of this time in England one must include Bright and Addison, attending physicians at Guy's Hospital in London,—the great men of Guy's. Disease of the kidneys is high on the list of conditions causing deaths to-day and was probably even more prevalent in the early nineteenth century. The most common manifestation of this disease is the accumulation of fluid in the skin and tissues (dropsy) and the presence of albumin in the urine. The association of albuminous urine with dropsy had been noted before this time especially by Wells, of South Carolina, and Saliceto in the thirteenth century had noted the occurrence of hard contracted kidneys in cases of dropsy. At the beginning of the nineteenth century although dropsy and albuminous urine were a common form of illness, the underlying condition was not known or recognized. Richard Bright (1789-1858), an unusually practical man and shrewd observer, noted the constancy with which he found the kidneys abnormal in appearance and structure at autopsy of persons suffering from dropsy and albuminous urine. He found also that this alteration from the normal was not always of the same

type, but that there was a variety of changes which occurred in such cases. In 1827 Bright published his *Reports of Medical Cases,* in which he gave the clinical histories of a number of cases with the urine findings, and a description of the kidneys with illustrations. Since then the name of Bright's disease and kidney disease, or nephritis, have been synonymous. Original descriptions of many other conditions, among them acute yellow atrophy of the liver, pancreatic diabetes and *status lymphaticus* were included in the volume. Bright had a large practice, was a popular consultant and an able geologist and botanist. His hobby was the collection of engravings, of which he was a discriminating judge, and he himself charmingly illustrated a book which he wrote on his Hungarian travels.

Thomas Addison (1793-1860), an attending physician at Guy's Hospital with Bright, was one of the first to point out the influence of the ductless glands of the body on health and disease. The chief of these glands are the thyroid, the adrenals and the pituitary. Addison was the first to describe a condition characterized by great weakness and pigmentation of the skin and mucus membranes which is associated with disease of the adrenal glands. This condition is known as Addison's disease. Addison was an inspiring lecturer and teacher, but his haughty and reserved manner, which really concealed a kindly but reticent nature, prevented his obtaining a large practice. He had such little faith in drugs that he often forgot to prescribe for his patients. Contemporary with Bright and Addison, Thomas Hodgkin (1798-1866) described a condition character-

ized by enlargement of the spleen and lymph nodes (Hodgkin's disease), and James Parkinson (1755-1824) first described paralysis agitans, or Parkinson's disease.

Karl Wunderlich (1815-1877), professor at Leipzig, was the originator of the application of thermometry to disease. In this way he established that fever, previously considered a disease in itself, was simply a manifestation or symptom of disease, and that the degree and course of the temperature helped to distinguish one disease from another. He introduced also the modern method of charting the curves of pulse, respiration and temperature. Thermometers in use at first were long and cumbersome things applied for at least five minutes to the axilla, or armpit. The pocket thermometer was not introduced until some time later (1868) by Sir Clifford Allbutt, Regius Professor at Cambridge. Physicians generally began to use clinical thermometers after 1870. In Austria the school at Vienna took on a new impetus from the inspiration from Paris and became one of the great centers of medical learning, attracting then as it does to-day students from all over the world. An early leader in this school was Josef Skoda (1805-1881) who introduced certain refinements in diagnosis by auscultation and percussion.

During the eighteenth century the true science of chemistry began to be evolved from alchemy. This evolution began with the work of such men as Robert Boyle, Lavoisier, Dalton, Cavendish and Humphrey Davy. It was natural that chemical knowledge as it de-

From an unsigned lithograph in the Collection of The New York Academy of Medicine

Figure XXV

LAENNEC

veloped should be applied to the study of the human body. The first use of this knowledge in methods of diagnosis was made in the examination of urine. Physicians had always given attention to this excretion as an aid in the study of their patient's condition. The medieval physician is often represented by the artists of the time as scrutinizing with deep interest and concentrated attention a flask of urine held up to the light. Conclusions were drawn from the color, transparency, odor and even the taste. A few facts of value were perhaps to be drawn from this method of examination, but the conclusions were for the most part without foundation and erroneous. Quacks made the most extravagant claims for uroscopy, as it was called, and honest physicians had many delusions about the meaning of changes in its appearance. In 1776 Mathew Dobson proved that the sweetness of the urine of diabetics was due to sugar. Frances Home in 1780 described a method of determining the presence of sugar in urine by the employment of yeast. William C. Wells in 1812 indicated the significance of the presence of albumin in kidney disease. In 1848 Hermann Fehling described a solution by which the quantity of sugar could be determined. In 1848 Heller perfected a urinometer by which the specific gravity could be discovered, and pointed out conclusions which were to be drawn from its variations. Gradually more difficult methods of analysis have been worked out, particularly in the quantitative determination of the nitrogenous excretion in the form of urea and uric acid.

Methods of examination of the blood from which

reliable diagnostic conclusions could be drawn were introduced much later. The old physicians who resorted to bleeding on every occasion believed they could deduce certain facts from the appearance of the blood and from the nature and rapidity of its clotting, but these inferences were as unreliable as their conclusions about the urine. Methods of blood examination have been worked out for the most part in the last fifty years. The enumeration of the red and of the white corpuscles per standard quality of blood has been made possible by the construction of glass chambers after the model of Richard Thoma and Karl Zeiss in which the blood is placed after accurate dilution by specially constructed pipettes. A reduction of the red cells indicates degrees of anemia, and the number of white blood cells, called leucocytes, in certain illnesses has thus become an index of an importance comparable to the degree of fever. Due largely to the efforts of Paul Ehrlich, the white blood cells may be differentiated and grouped in various types by their reaction to different stains. The variations from the normal of these different types form an important diagnostic criterion. In 1907 August von Wassermann discovered a method of examination of the blood which determined the presence of syphilis and which has proved of great diagnostic usefulness, particularly in cases in which the disease is latent. By the newer methods of analysis the quantity of certain constituents of the blood, such as urea and uric acid, shows the kidney function better than the examination of these waste products in the urine. The sugar in the blood may also be determined and is a great aid in the diagnosis and treatment of diabetes.

William Beaumont

The most noteworthy contribution by American physicians to the medicine of this period was that of William Beaumont (1785-1853). Beaumont, as a young surgeon in the American Army, was stationed just after the War of 1812 at Fort Mackinac in northern Michigan. Here one day a young *voyageur,* Alexis St. Martin, was accidentally shot in the abdomen. Beaumont, practiced in the treatment of gunshot wounds, took the young Frenchman into his own home and succeeded in nursing him back to health. As a consequence of the wound, however, a fistula, or opening leading from the stomach to the surface, remained, which St. Martin carried with him the rest of his life. Beaumont appreciated immediately the opportunity which this offered for the investigation of digestion in the stomach and began a series of careful investigations. The results of these investigations were published by him in a paper in the *Medical Recorder* in 1825. In this he described the appearance of the normal mucus membrane or lining of the stomach, and the motions of the stomach during digestion; he pointed out that gastric secretion occurred after taking food, and was not continuous, and gave his observations on the effects of the stomach secretion on various foods. He showed that the digestive juices of the stomach depended for their efficacy upon hydrochloric acid, and some other substance which he could not identify but which was later identified by Theodore Schwann as pepsin. This work of Beaumont's formed the starting point for our modern ideas concerning

digestion and dietetics. Beaumont was the first American experimental physiologist, and therefore deserves a high place in the history of American medicine. The patient, St. Martin, lived an active life despite his fistula, and died at the age of eighty-two.

Investigation of diseases of the stomach was aided by the work of Carl A. Ewald, of Berlin. John Hunter in 1790 was the first to feed patients by the introduction of a flexible rubber tube into the stomach. In 1875 Ewald began the study of stomach digestion by administering a test-breakfast of bread and tea, and an hour later extracting this meal by a rubber stomach tube. By titrating the stomach contents the amount of acid present could be determined and compared with the normal figure. The other digestive ferments could also be investigated, but tests of these have not proved of so much value.

Examination of the spinal fluid became possible when Heinrich Quincke in 1875 devised a method of inserting a special needle between two of the lumbar vertebræ into the spinal canal. Examination of the spinal fluid to determine its cell content and the presence or absence of bacteria is of great aid in diagnosis of diseases of the nervous system.

Probably the first instrument to be used for inspection of the interior of the body was the dental mirror. The date of its origin is unknown but mention of it is made by Celsus in the first century A.D. Modifications of the dental mirror have been used for examination of the throat and larynx for a long time. In 1851 Hermann von Helmholtz, Professor of Physiology at Heidelberg,

invented the opthalmoscope by which it was possible to observe the interior of the eye and examine the condition of the optic nerve and the retina. In 1877 Max Nitze introduced the cystoscope for the examination of the interior of the bladder. Since electricity has become available for illumination, instruments have been devised for the examination of the esophagus, the stomach and the intestine and bronchial tubes. Mechanical aid in the study of the heart and circulation is gained by the use of a number of instruments. Karl Vierordt in 1855 devised a sphygmograph for registering the pulse beat. Samuel S. K. von Basch in 1887 devised the sphygmomanometer, an instrument for measuring the blood-pressure. Numerous improvements have been made in both the sphygmograph and sphygmomanometer since they were first introduced.

Simultaneous records of the arterial and venous pulses were first made by Sir James Mackenzie whose researches shed much light on diseases of the heart. E. J. Marey in 1876 and A. D. Waller in 1889 began the study of the electric currents generated by the contraction of the heart muscle. Later William Einthoven succeeded in constructing an instrument which, when connected with the human body, picked up the feeble electrical currents generated by the heart and conducted them through a delicate string of platinum placed between the poles of an electromagnet. The deflections of the string caused in this way are photographed upon sensitized paper and are called electrocardiograms. This machine called the electrocardiagraph is helpful in diagnosticating the various irregularities of the heart and in

giving indications of the condition of the heart muscle. Much valuable work in the interpretation of electrocardiograms has been done by Sir Thomas Lewis, of London.

Overshadowing other instrumental methods, the Roentgen or X-ray in the last twenty years has assumed a more and more important rôle in diagnosis. The X-ray was discovered in the latter part of the last century when Sir William Crookes sealed a positive and negative electrode in either end of a vacuum tube. When this tube was placed in an electric circuit a bright fluorescent light resulted. What occurs in such a tube at this time and how its investigation has resulted in revolutionary changes in chemical theory as regards the division of atoms into electrons does not concern us here. Wilhelm Konrad Roentgen in 1895 covered one of these tubes with an opaque substance, a substance which sunlight could not penetrate, and exposed a light-sensitive plate to it. To his surprise he found that this plate had been affected by this exposure.

Improvements on the Crookes tube have been made by Dr. W. D. Coolidge. The Coolidge tube is the familiar X-ray tube, globular in shape with glass elongations in which the negatively charged, electric particles are focused. When these particles strike the metal screen the so-called X-rays are given off. These rays have exceedingly short wave-lengths as compared with sunlight, and for this reason can penetrate substances of much closer texture than can be penetrated by ordinary light rays. The X-rays are capable of passing through the human body, and this fact was soon made use of in diag-

nosis. The degree to which they penetrate the body varies with the density of the structure of the various tissues.

When a portion of the body is interposed between the X-ray tube and a photographic plate the surface of the plate is affected in accordance with the number of rays which each tissue permits to pass through. The bones, being the densest, form the most definite shadows on the plate; the muscles, which are more penetrable, cast much fainter shadows. The heart, with its very thick musculature, casts a well-defined shadow. The lungs in health are of course easily permeable and cast a diminished shadow, but in conditions of inflammation or scarring, subsequent to inflammation, certain areas in the lungs become more resistant to the rays and cast shadows upon the plate which make it possible to diagnosticate and outline processes of inflammation. The hollow organs are easily penetrated by the rays, but they may be outlined by filling them with some radio-opaque substance such as bismuth or barium or solutions of the salts of iodic acid. To outline the stomach a mixture of barium and buttermilk is swallowed by the patient. Under these circumstances the stomach casts a denser shadow and as it empties itself into the intestines the latter can be outlined in the same manner. In this way by means of the X-ray, deformity of the normal contour of the stomach by lesions such as ulcers or growths can often be demonstrated.

The uninformed layman usually thinks that an X-ray of the interior of his body will reveal the condition of his organs with the same detail as that of an ordinary

photograph. If this were true, the work of the physician would indeed be easy, but X-ray photographs are after all simply contrasts of light and shadow and in the diagnosis of disease the evidence obtained by the X-ray must be correlated with that found on examination of the patient by other means. This, as in other diseases, is true of chest conditions, and the methods of Auenbrugger and Laennec still hold their important place in diagnosis to-day.

One of the greatest additions to the scientific diagnosis of disease has been added by the results of the work of Pasteur in bacteriology. The bacteriological laboratory now offers a rapid and certain diagnosis in many groups of diseases. It also furnishes in some cases a brilliant method of attack in the use of bacterial products which have a specific action against certain of these disease germs. The differential diagnosis of various kinds of inflammation of the throat is largely made by the isolation of the causative germ and not by a study of the clinical picture. The discovery of the germs of typhoid fever, of the tubercle bacillus, of the germs causing septic infection, and, in so far as they have been isolated, the culture from the blood or excretions of the patient of the bacteria of other infectious diseases has given the practitioner of to-day a rapid and accurate method of diagnosis. This has led on the part of physicians, especially of the younger ones, to a neglect of a careful study of the history and symptoms of disease. In endorsing the use of the microscope and the laboratory to his students, Christian Fenger, one of the brilliant surgeons of America in the nineteenth century, spoke of

the microscope as being "only a symptom." Niceties of bacteriological diagnosis are complicated and therefore subject to human interpretation and to error. It can easily happen that a patient may get well before the final laboratory solution of his diagnostic problem has been completed. The field of bacteriology in the diagnosis of disease is not limited to the mere cultivation of germs, but many physical and chemical reactions between the blood of the patient and the growing germs have been applied to this branch of medicine. Examples of such reactions are the effects of the blood of patients suffering from typhoid fever upon the activity of a culture of living germs, which was discovered by Dr. Ferdinand Widal, of Paris, and the differentiation of the different types of pneumonia as developed in the Rockefeller Institute.

The application of laboratory methods of all kinds, including the examination of simple tissues by the microscope and the application of physics and chemistry in studies of the serum of the blood, has added much to the powers of diagnosis, but the physician should always forget short-cuts and simple methods of diagnosis, and continue to follow the methods of Sydenham, Laennec and Jenner in the study of disease for it is equally true to-day, as it was in the time of Hippocrates, that "experience is fallacious and judgment difficult."

XIII

JENNER AND PASTEUR

The Foundation of Bacteriology

SMALLPOX has existed since the earliest times. The Arabian physicians were the first to distinguish it from measles. Until the beginning of the nineteenth century it was an endemic disease throughout the world and at intervals became epidemic. It is estimated that in England during these years one out of every fourteen persons born died of the disease. Of every five or six persons who contracted smallpox, one died. Sydenham regarded smallpox as a natural process through which every individual must pass at least once in his lifetime. The man who was responsible for relieving humanity of this scourge, one of the greatest that ever afflicted man, was Edward Jenner.

Edward Jenner

Edward Jenner, the son of a clergyman, was born in Berkeley, Gloucestershire, on May 17, 1749. After receiving a private education, he was apprenticed to a physician for a short time in Gloucestershire, and afterward went to London and became a student of John Hunter in whose house he lived for two years. Jenner had in his youth always shown a strong interest in the habits of animals and birds, and Hunter found him an

apt and congenial scholar. Because of his love for the country Jenner preferred the life of a country practitioner to that of a city physician and returned to Berkeley to practice. From here he carried on a correspondence with Hunter, supplying the latter with fossils and specimens of bird and animal life and conducting experiments in hibernation suggested by Hunter. One of Jenner's first scientific papers was an account of the life of the cuckoo, explaining its peculiar breeding habit of laying its eggs in the nests of other birds, and having its offspring reared by foster-parents. Jenner, a genial and unassuming gentleman much loved by his friends for his kindliness and comaraderie, was fond of loitering in country lanes, absorbed in the scenery and observing the birds. He wrote several poems of merit the best known of which is the *Address to a Robin.* His portrait is shown in Figure 26.

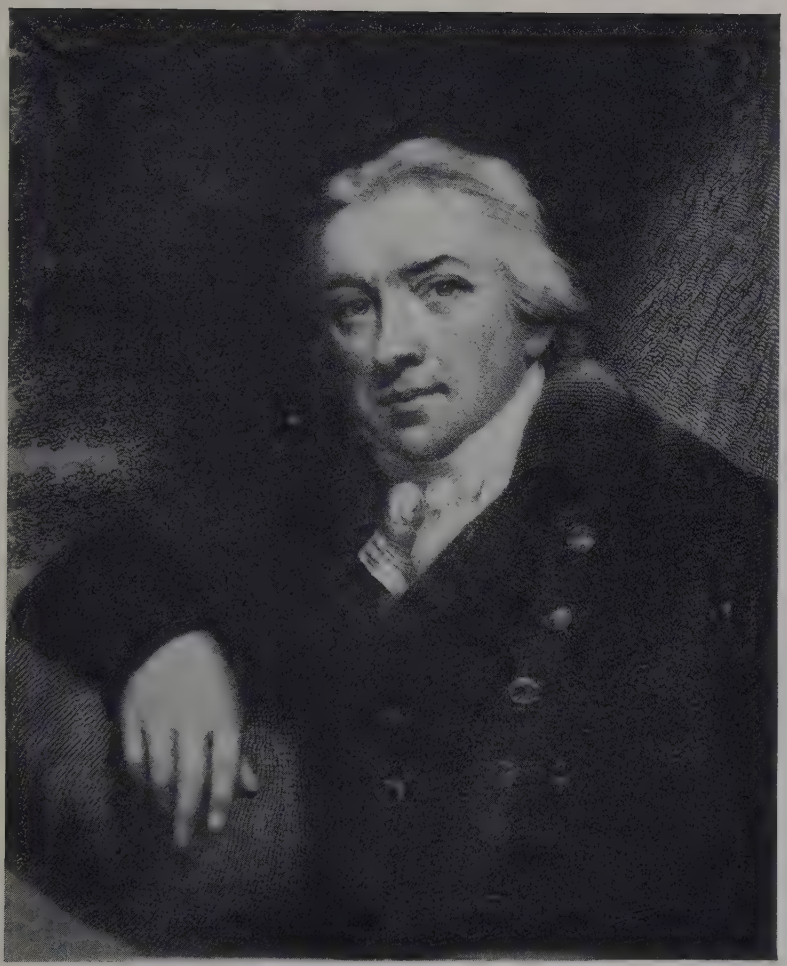
Jenner's attention was first drawn to the subject of smallpox prevention when he mentioned the disease in the presence of a dairymaid who asserted she could never take it because she had had cowpox. This was at the time Jenner first began to study medicine. In London he frequently mentioned this idea to physicians, but they paid little attention to him. Inoculation against smallpox had probably been practiced in ancient times, especially in the East. By this method matter from the pustule of a mild case of smallpox was rubbed into a small incision of the skin of the person to be protected. In 1718 Lady Mary Wortley Montagu had one of her children inoculated successfully in Turkey and later another one in England. This gave the method an impetus in Eng-

land. Inoculation of this kind usually resulted in a mild attack of smallpox which protected the individual from further attacks.

But the resultant disease was not always mild; in fact it was estimated that one out of fifty of those inoculated died. In addition those suffering from the disease induced in this way could and did help to spread the disease. Such a localized epidemic was reported by Willan (1757-1812), during which sixty-eight persons contracted the disease from one child who had received a preventive inoculation. This outbreak resulted in eight deaths among the sixty-eight patients.

Jenner began his investigation of the tradition among the country folk that an attack of cowpox conferred immunity to smallpox in 1778. Some of the dairymen insisted that an individual who developed an eruption on the hands after milking cows with such an eruption on their udders never took smallpox. Others insisted that they had had such eruptions and had subsequently suffered from smallpox.

Jenner found that cows, sheep, swine and horses suffered from localized eruptions resembling the diffuse pustular eruption of smallpox in man. In the horse there was a condition called "grease" which affected the heel and caused swelling and blistering. The cows apparently became infected from horses with the grease on the same premises. It was Jenner's opinion at first that this condition of the horse was the means of giving the smallpox to humans and cowpox to cattle. Later, he concluded that the grease and cowpox were both attenuated forms of smallpox, attenuated because of the



From an engraving by C. Scriven, in Author's Collection

Figure XXVI

JENNER

natural resistance of the animals to the disease. He found too that there was a variety of eruptions from which cows suffered, all of which were called cowpox by the laity. Finally, he determined that true cowpox was characterized by a particular type of pustule and that individuals infected with the matter from such a pustule, particularly at a certain stage of the pustulation, did in fact gain immunity from smallpox. An individual infected in this way developed in the course of seven to ten days at the site of the abrasion where the matter entered, a pustule with a reddish areola about it and mild constitutional symptoms. Furthermore the lymph, or matter, from this pustule in the human could be used successfully to inoculate other humans. In 1796 Jenner inoculated a farmer's boy, James Phipps, with the matter from the arm of a milkmaid, Sarah Nelmes. This proved successful in protecting Phipps against smallpox since attempts thereafter to inoculate him with true smallpox matter failed.

In 1798 Jenner had collected twenty-three successfully vaccinated cases, and in this year he published his little book called the *Inquiry*. In this he described and gave illustrations of the lesions of true cowpox and showed the proper time and way to obtain matter from the cowpox pustule, and the proper way to employ this matter to vaccinate men against smallpox. He pointed out that the individual thus vaccinated developed a pustule at the site of the inoculation, but that he did not develop the general eruption which occurred after inoculation with matter from the pustules of the disease itself, and that he did not become infectious to others. He showed

that matter from the pustule thus produced could be used to vaccinate others, though he preferred for vaccination the use of matter from pocks of a spontaneous outbreak in cattle.

After the publication of the *Inquiry* Jenner went to London in an endeavor to interest physicians there in his method of vaccination. The method, however, was confused with true smallpox inoculation and regarded by the laity with apprehension. Though he remained in London for three months, Jenner did not obtain an opportunity to demonstrate his method. After this, a celebrated physician, Doctor Cline, with whom Jenner left some of his virus, inoculated a child who was suffering from hip-joint disease. In this case he did it primarily to relieve the hip trouble, believing that the pustulation in the region of the hip would be beneficial. The vaccination against smallpox proved successful, since attempts afterward to inoculate the child with true smallpox failed, showing that the child had gained immunity as a result of her vaccination. In this way the Jennerian method of vaccination was brought favorably before the public. Vaccination was gradually adopted by the profession and an increasing number of individuals were vaccinated annually.

Strangely enough, the method was much more quickly adopted in foreign countries than in England. In a short time it came into wide use in Austria, France, Prussia, Sweden, Denmark and America, and was practiced in India and the Far East. In America President Jefferson vaccinated his own family soon after learning of the method. Denmark and Sweden and some parts

of Prussia made it into a compulsory health measure.

In England, however, it was not long before strong opposition developed to vaccination, and in many quarters Jenner was subjected to hostile and sometimes insulting criticism. This was brought about in several ways. There was the usual jealousy of members of his profession and skepticism of new methods. Failures and fatalities occurred, and these were harped upon by the anti-vaccinationists. These resulted almost always from an ignorance of Jenner's true method and failure to follow his directions. The method was used in the London Smallpox Hospital and many persons inoculated there developed true smallpox. Fair-minded persons appreciated that the premises of a smallpox hospital were no place to undertake vaccination because of the danger of contagion and of contamination of instruments by smallpox matter, yet in the hands of the anti-vaccinationists these cases were used as convincing arguments against Jenner.

Besides this, vaccination as practiced by many unscrupulous persons often resulted badly. As the cowpox lymph was difficult to obtain these persons used and sold for vaccination purposes the threads from the shirt-sleeves of vaccinated individuals which had become saturated with the matter from a discharging vaccine pustule. Vaccination performed under these circumstances naturally often resulted in failure if nothing worse. Jenner, despite the criticism and opposition to his method, sometimes by men of authority in the profession, was convinced of the efficacy of vaccination. He pursued a dignified course, replied patiently to

critics and took great satisfaction in feeling that in time his method would relieve humanity of great suffering.

The efficacy of vaccination became more apparent each year. In Denmark where vaccination was made compulsory the following figures illustrate its success:

In the year	1779	the	smallpox	destroyed	15,000 persons
	1784	"	"	"	12,000 "
	1800	"	"	"	12,000 "
	1801	"	"	"	6,000 "
	1822	"	"	"	11 "
	1823	"	"	"	37 "

From the foreign countries Jenner received many addresses expressing praise and gratitude. He was made a member of numerous foreign scientific societies. A letter from him to a friend bearing his signature was accepted in foreign countries as a passport. He petitioned Napoleon to liberate a friend of his who was held a prisoner. Napoleon, upon being informed from whom the petition came, remarked: "Ah, Jenner, we can refuse that man nothing," and ordered the petition granted.

In replying to inquiries, in obtaining and supplying lymph for others to use in vaccination Jenner was put to a great deal of expense and sacrificed much time which he needed for his practice and livelihood. His friends had introduced into Parliament a bill to reward him for his discovery and to help him to pursue his investigations. In the discussion as to the amount to be granted, it was pointed out that had Jenner kept his discovery secret it would have been the means of making him im-

mensely wealthy. After much discussion a grant of ten thousand pounds was made and some years later a second grant of the same amount was added. For a period after the introduction of vaccination, Jenner practiced in London, but he found the call of the country too strong for him and returned to the quiet of Gloucestershire where he could enjoy the country life that he loved. The death of Mrs. Jenner, who had always been a source of help and encouragement to him, saddened his later years. He died suddenly in 1823 of apoplexy at the age of seventy-four.

The brilliant work of Jenner on the prevention of smallpox was a discovery not in the art of diagnosis nor in the science of pathology. He did not find the cause of the disease and added nothing to its treatment. He opened up, however, a new vista in medical science and started the world thinking on lines of public health and preventive medicine. The results, however, were slow to follow. It is a striking criticism of the forgetfulness and stupidity of the human race that the procedure of Jenner is not even to-day universally applied. The results of the law for compulsory vaccination which was put in force in Denmark at the beginning of the nineteenth century have been given above. Vaccination is carried on to-day in the countries of Continental Europe with a very general unanimity. But in Great Britain and especially in the United States the laxity with which existing laws regarding vaccination are enforced is a severe condemnation of the Anglo-Saxon peoples. In the United States of America the nearest approach to an efficient law is that requiring vaccination of all chil-

dren attending public schools. This postpones the compulsory vaccination of the population until the sixth year of life for some and indefinitely for those who are not attendant at the municipal schools. As a result there are in the United States in every year more cases of smallpox than occur in all the rest of the civilized world combined.

Holmes and Semmelweis

Jenner's discovery was made by an observant practitioner and was based entirely upon observation of clinical facts. A second great discovery in preventive medicine was also largely the result of a single observer and was placed before his colleagues entirely as a result of logical conclusions also drawn from clinical study. It had to do with an application of therapeutics and related to the scourge of puerperal fever, outbreaks of which were frequent both in the hospitals and in the homes of the patients. The New York Hospital, for instance, suffered from no unusual experience when it felt compelled to close its obstetric service in 1828 because of the high mortality from infection in childbed which occurred in its ward.

Oliver Wendell Holmes (1809-1894), who is remembered usually for his literary achievements rather than for his noteworthy influence on medicine, read before a Boston medical society in 1843 a paper on the contagiousness of puerperal fever in which he asserted that puerperal fever might be and probably was conveyed by physicians who attended other cases of puerperal fever or who attended post-mortem examinations.

To prevent this he advised physicians after attending cases of puerperal fever to change their clothes and to scrub their hands and nails with calcium chloride. These assertions of Holmes met with a great deal of opposition from obstetricians, but in 1855 in a second paper entitled *Puerperal Fever as a Private Pestilence* he drew attention to the work of Semmelweis who had arrived independently at Holmes's conclusions and whose investigations sustained Holmes's premise without question.

Ignaz Philipp Semmelweis (1818-1865) was an outstanding member of the new Vienna School. He was born in Hungary and had been a pupil in Vienna of the clinician, Skoda, and the pathologist, Rokitansky. He was in charge of one of the two obstetric wards at the Allgemeines Krankenhaus in Vienna in 1846. In this ward medical students were instructed in obstetrics. The other ward was in charge of midwives and their students. The mortality was so high in Semmelweis's ward that patients often refused to enter the hospital unless they could be admitted to the service of the midwives. Semmelweis noted that students came to his ward directly from the autopsy room to deliver women in labor. He studied carefully the autopsies of women who died of puerperal fever, and one day while present at the post-mortem examination of one of his colleagues who had died of a dissecting-room wound, he noted the similarity to the findings in the cases of women dying of puerperal sepsis. He recognized that both were instances of a general blood poisoning. Consequently he immediately introduced methods of scrupulous clean-

liness, insisting that any one who practiced in his ward should scrub the hands with calcium chloride. In two years he reduced the mortality from nine and nine-tenths per cent. to one and two-tenths per cent. His ideas were opposed and ridiculed by many of the obstetricians of his time, although the leaders of the Vienna School, Skoda and Rokitansky, championed them. This opposition and criticism seemed so unjust and groundless that it preyed upon his mind, and Semmelweis, the savior of countless mothers, died insane at the age of forty-seven.

Holmes and Semmelweis had many followers in the general profession, although the professors in the schools and men who should have been leaders in medical advance were too often numbered among their opponents, and it was not until the work of Lister in general surgery became thoroughly understood that obstetrics followed along the same lines of preventive medicine and became an aseptic branch of medical therapeutics.

Louis Pasteur

Leeuwenhoek and other pioneers in the use of the microscope in the seventeenth century had described the infinitely small forms of life which their lenses had revealed to them. The significance and origin of these minute bodies were not understood until investigated by the brilliant French scientist, Louis Pasteur. Louis Pasteur was born at Dôle, December 27, 1822. His father, Jean Joseph Pasteur, had served as a sergeant-

major in the armies of Napoleon and had earned the cross of the Legion of Honor. On leaving the army, he settled eventually at Arbois and became a tanner. He had four children, three daughters and the son, Louis. The father was an upright and industrious man who by dint of hard work and thrift managed to supply his family with the ordinary wants of life. The interest and ambition of the family centered about the only son for whose education it was ready cheerfully to make any sacrifice. As the son progressed in his studies the father endeavored by reading and study to familiarize himself with the subjects of his son's courses in order to appreciate and understand the young man's interests. After completing his preliminary education Pasteur entered the École Normale at Paris where he became especially interested in chemistry and physics. After graduation he became professor of chemistry at the University of Strassburg and later held similar positions in different universities in France until he returned to Paris to become director of scientific studies at the École Normale.

Pasteur's first notable contribution to science was in an investigation of crystals. Chemists had always been puzzled by the two substances, tartaric acid and paratartaric, or racemic acid. These substances seemed almost identical, yet when polarized light was directed through a solution of tartaric acid it was deflected to the right, while it passed through a solution of racemic acid without deflection. Pasteur, seeking an explanation for this, undertook the study of the crystals of these two substances. After painstaking investigations

he found that the crystals of tartaric acid had little facets on them on only one side, the right. Crystals of racemic acid had facets on both sides, and he was able to split up racemic acid into a right-sided faceted tartaric acid and a left-sided tartaric acid. The facets of the two tartaric acids were similar in shape but could not be superimposed on each other any more than a right-handed glove could be fitted on the left hand. Pasteur next found that if he carefully separated the right- and left-sided crystals from each other a solution of the right-sided crystals was dextrorotary and gave the same deflection of polarized light as tartaric acid, and the left-sided crystals of metatartaric acid in solution was levorotatory, while if he mixed an equal quantity of the right-sided and left-sided crystals he obtained a solution which, like racemic acid, had no effect upon the ray of light. These investigations of Pasteur caused a sensation in the chemical world. The relation of tartaric to racemic acid had engaged the attention of chemists for a long time. At first Pasteur's announcement was received with skepticism but its truth was soon confirmed by others, and Pasteur was awarded the Rumford Medal of the Royal Society in recognition of his work.

Pasteur next took up the question of fermentation. The nature of the production of alcohol from sugar up to this time was considered purely a chemical reaction. The agency of micro-organisms in bringing about the change as part of their own life processes was not considered. Brewers added yeast to their mash of grain and obtained fermentation and production of alcohol,

but this they considered simply in the light of one chemical substance reacting upon another to form a third substance. Pasteur undertook an investigation of the brewing industry primarily to improve the French product and to enable it to compete with that of foreign brewers. In this way he demonstrated that the alcohol was the result of the action of yeast cells upon the sugar, and that they brought about this change not by an inanimate chemical combination but as part of the process of their own life in creating food for themselves. Moreover he demonstrated to the brewers that there were different types of yeast recognizable from one another under the microscope. Some of these produced good beer while others brought about deleterious changes which resulted in slimy or acid conditions of the beer which rendered it unfit to drink. After some hesitation and reluctance in accepting Pasteur's ideas, the brewers eventually supplied themselves with microscopes and learned to recognize a good yeast and to safeguard their brew from contamination by harmful yeasts.

Pasteur after this was asked to give his attention to the wine industry. The French wines were of course conceded some of the best in the world, but they were not considered good for export because of their poor keeping qualities. If kept too long they often became ropy or sour. Pasteur, after long investigation, found that there was often present in the wines an oily scum on the surface which under the microscope was shown to consist of myriads of small organisms, the mycoderma aceti. By acting on the wine this organism created acetic acid or vinegar. He showed that if the wine

were heated for an hour to a temperature of fifty to fifty-five degrees Centigrade these organisms were killed, and if the bottles were then sealed to prevent further entrance of the organism the wine would keep indefinitely. There are always people ready to oppose any new idea and many insisted that heating the wine in this way would prevent its aging, but Pasteur insisted that it would have no effect on the aging, which he said was a matter of oxidation, and eventually his ideas were accepted.

In the meantime the vinegar industry was in difficulty because frequently their vinegar became spoiled. Turning his attention to this subject, Pasteur found that while the mycoderma aceti was often responsible for the ruin of good wines it was the essential agent in the production of vinegar. But the vinegar-makers found that often the process of vinegar formation seemed to progress favorably to a certain point and then the vinegar vanished. Pasteur, investigating the mycoderma aceti further, found that it acted upon the alcohol in the wine to form vinegar, or acetic acid, but that after transforming all the alcohol into acetic acid it then began to act upon the acetic acid itself to transform it into carbonic acid gas and water, and that in this way the vinegar was lost. He demonstrated to the vinegar-makers that if the mycoderma was killed by heat at the proper time the vinegar could be preserved.

After rendering such successful aid to the wine and vinegar industries it was natural that when the silkworm growers found themselves in difficulty they should appeal to Pasteur for help. For some years the silkworms of France had been attacked by a disease which now

threatened utterly to destroy the manufacture of silk in France. The disease of the silkworm, called pebrine, was characterized by the formation in the worms of small corpuscles or spots resembling pepper seeds. In certain years the eggs developed into healthy worms which spun good cocoons, but the eggs of the moths springing from these cocoons in the following year hatched into unhealthy worms which often died before forming new cocoons. The silk-growers would thus have a prosperous year and begin the next year with every hope of a repetition of the success of the previous year only to lose their entire crop. New seed or eggs would be purchased, but these were as likely to fail as to succeed. After five years of investigation, which began as a baffling and often a seemingly hopeless quest for a remedy, Pasteur found that if the moths were ground up after laying their eggs and examined under the microscope for pebrine corpuscles it was possible to select the eggs of moths free from such corpuscles and save only these for hatching, with the result that in the following year a healthy crop of silkworms could be insured. This method was instituted with success and everything seemed to be going well when the silkworms again became sick in enormous numbers. Pasteur's critics immediately asserted that in reality he had not solved the problem at all. Once more Pasteur took up the problem only to find that the silkworms were susceptible not to one but to two diseases. He identified the second disease, flacherie, with less difficulty and was soon able to lay down principles for its prevention.

During his investigations of the fermentation of beer

and wine, Pasteur became intensely interested in this world of infinitely small living organisms which brought about fermentation and other changes in organic matter. Where did these thousands of infinitesimal bodies come from? The theory of spontaneous generation was at that time generally accepted, though a few had questioned it. According to this theory, these organisms formed themselves spontaneously out of the elements of the substances in which they were found. In other words, they were supposed to originate not from parent organisms but to arise spontaneously. Various formulas were given in all seriousness detailing the proper ingredients to be mixed to result in the generation of certain forms of life.

Pasteur was convinced that there was no such thing as spontaneous generation, and it required his genius for experiment to produce such convincing proof that the theory of spontaneous generation was discarded for ever. His aim was to show that liquids which are susceptible to putrefaction or fermentation only undergo such changes if exposed to air and the micro-organisms always present in it. In the first place he took a number of flasks of yeast-water and heated these to kill whatever organisms might already be present and then sealed the flasks. Assuming that air at high altitudes was more pure and contained fewer organisms than the dust-laden atmosphere of Paris, he undertook a journey to the Alps. At different levels he unsealed an equal number of his flasks and exposed them for a given time to the air. Upon his return to his laboratory he examined these flasks and found that while the flasks

exposed in dusty atmospheres all showed contamination with micro-organisms, the flask exposed to the air at a high altitude rarely showed this contamination. He next devised a method of drawing the necks of these glass flasks out into the shape of the letter U. In this way air could find entrance to the flask but the dust contained in it was deposited at the bottom of the U-shaped neck before the air came into contact with the contained fluid. Under these circumstances the liquid remained devoid of any life, but if the flask were tipped to allow the liquid to come in contact with the point in the U where the dust was deposited, the liquid quickly teemed with micro-organisms. Further, Pasteur found that if air was filtered through sterilized cotton before it came in contact with the liquid, no growth occurred, and yet if a single strand of the cotton thus used to filter the dust from the air was placed in the liquid, this liquid quickly became overgrown with micro-organisms. These experiments convinced the majority of the fallacy of the theory of spontaneous generation, but many champions of the theory appeared. There were frequent and tedious debates at the French Academy of Science in which Pasteur and his ideas were attacked, but Pasteur was simply stimulated by the opposition and succeeded by further experiments in demolishing the arguments of his opponents.

At this time, at the age of forty-six, Pasteur suddenly developed a stroke of apoplexy. For days his life was despaired of, and his family and friends expected momentarily the end of a career which still held such brilliant promise of usefulness to humanity. Gradually

he passed through the crisis and began to regain his health. The stroke left him with a limp and a certain awkwardness in the use of one of his arms which he retained throughout the many remaining years of his life.

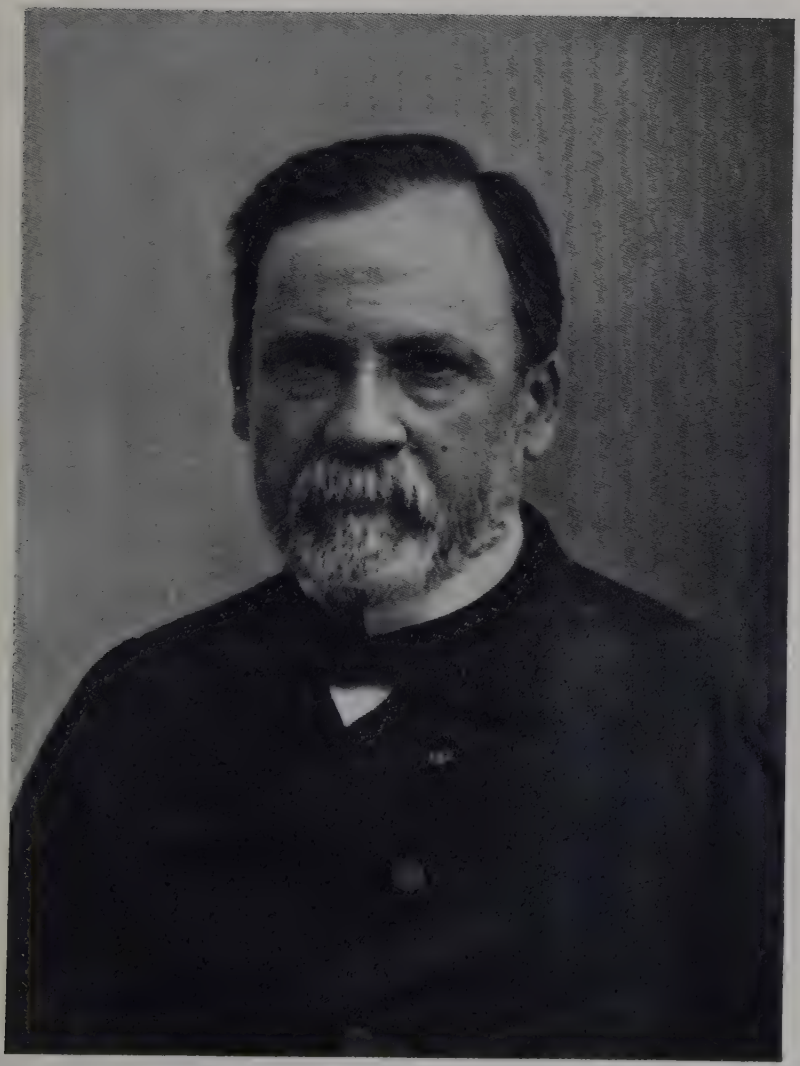
When once again able to take up his work, Pasteur began to think of the relationship of micro-organisms or microbes to disease. At the Academy of Medicine he had on one or two occasions spoken to the physicians of the possible relationship of microbes in the air, or in the dressings, to the cause of the suppuration or pus formation in wounds, and had advised them to pass their instruments before using them through a flame to destroy the microbes present and also to sterilize with heat at a high temperature the gauze used in dressings. This advice at the time was not given any very serious consideration.

In 1879 the sheep and cattle in France were suffering from and being decimated by a disease called charbon, or anthrax. Apparently healthy animals suddenly drooped, became short of breath and exhibited sanguinolent discharges from the bowels and mouth. Whole flocks succumbed in a few days to the disease. Veterinarians were at a loss to explain the cause and nature of the disease. And again France called upon Pasteur. It had been noticed by some veterinarians that the blood of the animals dying of anthrax examined under a microscope contained hundreds of small rod-shaped organisms. Pasteur obtained some of the blood of diseased animals and caused the death of other animals by injecting this blood into them. He announced that he

considered these rod-shaped bodies the cause of the disease. Others asserted that because these organisms were present in the blood there was no proof that they in themselves produced the disease, and that the cause might be some entirely different and undiscovered virus. To refute this statement Pasteur succeeded in growing these bacilli in a pure culture by adding a drop of the diseased blood to a flask containing the culture medium. Taking a drop from this culture and adding it to another flask he was able to propagate the growth from one flask to another until he had inoculated forty new flasks. From the last flask he obtained bacilli with which he was able to cause the death of animals from anthrax. Since, if the disease were due to some virus other than the bacillus, this virus would have become diluted to infinitesimal proportions in the transfer of a single drop from one flask to another, Pasteur asserted that the contention that the bacilli were not the active agent was untenable. But other opponents arose to say that the blood of any dead animal contained microbes whether they died of anthrax or were simply asphyxiated, and that their blood would cause the death of other animals. They demonstrated the truth of this, and for a time Pasteur was perplexed. Soon he discovered, however, that while the bodies of dead animals after a number of hours did become septic from invasion of the tissues by the colon bacillus normally present in the intestine in life, that this did not occur for several hours after death. He pointed out on the contrary that when animals died of anthrax, the anthrax bacillus was present not only before but immediately after death. The blood of the animal dead of

anthrax was virulent from the start, while the blood of an asphyxiated animal did not become harmful until some sixteen hours after death when the septic organisms had had time to develop.

One of Pasteur's most vigorous critics was Professor Colin who seemed to take pleasure in contradicting Pasteur on any pretext. At one meeting of the Academy, Pasteur stated that he had been unable successfully to inoculate chickens with anthrax. Colin said that nothing was easier. Pasteur defied him to do it and even supplied him with a culture of anthrax bacilli with which to work. At intervals Pasteur asked Colin where the infected chicken was which he had promised. Colin put Pasteur off from month to month with various excuses but eventually admitted that Pasteur was right and that chickens could not be infected with anthrax. In the meantime Pasteur had conducted some researches of his own and told Colin that at the next meeting of the Academy he would produce a chicken dead of anthrax. Pasteur had found that the body temperature of birds was higher than that of mammals, and that anthrax bacilli would not thrive in the temperature of the blood of a chicken. By immersing one-third of the body of a chicken in a tub of cold water, Pasteur succeeded in reducing the body temperature to such a degree that the chicken quickly succumbed when injected with a culture of anthrax bacilli. At the next meeting Pasteur appeared with a cage containing one dead and two live hens. One hen had been inoculated with anthrax and left in its cage, this hen was perfectly well. A second hen had been immersed in cold water but had



From a photograph in the Collection of The New York Academy of Medicine

Figure XXVII

PASTEUR

not been injected, the bath had done no harm and the hen was well. The dead hen had been inoculated and then kept in a bath of cold water and had died of anthrax.

While investigating anthrax, Pasteur was also conducting researches on chicken cholera. This is a virulent disease among fowl, appearing in epidemics in barnyards and killing entire flocks. He succeeded in isolating from the blood of chickens with the disease a very small rod-shaped organism with thickened ends. He had some difficulty at first in finding a medium on which this organism would grow, but found eventually that it flourished in a broth made of chicken gristle. He found that injections of this organism into rabbits or chickens killed them. On the other hand if injected into a guinea-pig a localized abscess formed, but the animal was not made sick and always survived the injection. Yet if an abscess induced in this way in a guinea-pig ruptured and the food of a chicken or rabbit in the same cage became contaminated with the pus, the chicken or rabbit quickly succumbed to chicken cholera. This fact led to no immediate practical result but was an evidence of the different reaction to a specific micro-organism of different species or it might be of different individuals of the same species.

On one occasion Pasteur, going on a short vacation, left in his laboratory some tubes containing cultures of the cholera bacillus. Returning two weeks later, he found these stale cultures and attempted to use them in inoculating some fresh chickens to pursue his investigations. To his surprise the quantity of these stale cul-

tures, which had the culture been fresh would have been fatal, scarcely made the chickens sick. By chance he had discovered that the virulence of the culture had been attenuated by becoming stale. Now he tried inoculating the chickens previously inoculated with the old culture with a fresh culture. He found that the previous inoculation had protected them from a lethal dose of fresh culture. In this way he found an efficacious method of vaccinating against chicken cholera.

The problem of attenuating the anthrax bacillus in order to make a vaccine was more difficult. The anthrax bacillus forms within itself small bodies called spores. In an unfavorable environment the body of the bacillus may disappear, but the spores are very resistant and may exist indefinitely in dust or dry earth, and then if placed in some suitable medium for growth, develop into the typical bacilli and multiply by division. In this way they may be compared in their method of propagation to plants which may be grown from seeds or from cuttings. Pasteur, therefore, could not obtain attenuation of the virulence of the anthrax bacillus simply by allowing a culture to dry out. Eventually he found that if they were grown under a continuously high temperature (forty-two degrees Centigrade) they lost their virulence permanently and did not regain their virulence even if placed again in a suitable environment. Using this method, he prepared vaccines from the bacilli thus attenuated and found that after injections of such a vaccine animals became immune to the injection of virulent organisms.

When Pasteur made the announcement of this fact he

was invited to demonstrate the usefulness of the method by one of the county agricultural societies. There were many skeptics who frankly expected him to fail, and some jealous individuals who even hoped that he would. Fifty sheep were placed at his disposal. Twenty-five of these were to receive at an interval of two weeks two injections of the attenuated bacilli. The other twenty-five sheep were not to be inoculated, but finally the whole fifty sheep were to receive injections of lethal doses of the virulent bacilli. Pasteur boldly predicted that all of the unvaccinated sheep would die, and that all of the vaccinated sheep would survive. Pasteur and his assistants, Roux and Chamberland, made the preliminary injections of vaccines in the group of twenty-five sheep. Two weeks after the last injection, Pasteur in the presence of a large crowd of farmers, veterinarians and physicians injected each of the fifty sheep with a more than fatal dose of virulent anthrax bacilli. The official observers took every precaution to see that the test was rigidly supervised. Vaccinated and unvaccinated sheep were injected alternately; the syringe was well shaken before each injection. On completion of the injections the committee took a recess for two days to see what the result would be. The following day several of Pasteur's vaccinated sheep appeared droopy and some of them had temperature, but every one of the unvaccinated animals was decidedly ill. The following night was an anxious one for Pasteur. Had he claimed too much? Would those vaccinated sheep which were unwell be dead the following day? When the following day came every one of the unvaccinated sheep had died,

every vaccinated sheep appeared well and healthy, and remained so! For this France granted Pasteur the Grand Cordon of the Legion of Honor which he refused until crosses were also offered to his two faithful assistants, Roux and Chamberland.

Pasteur was now to accomplish a work for which he is best known because of the direct benefit to be derived from it by humanity. His work on micro-organisms initiated a new era in the conception of disease: it opened up a field which his followers in many countries were to explore, and as a consequence accomplish more in the conquest of disease in a period of years than had been accomplished for centuries before. This effect of his work was in a sense an indirect one. His work on hydrophobia or rabies seemed to the general public a more specific and a more tangible benefaction to humanity, and for this reason this phase of his work is the one with which his name is usually associated. Hydrophobia was a particularly difficult problem for experimental study, not so much because of the danger of handling rabid animals but because at first Pasteur had difficulty in experimentally producing the disease in laboratory animals. At first he naturally attempted to produce the disease by injecting the saliva of human victims of rabies or that of animals, but saliva even in healthy persons usually contains pathogenic organisms and these often killed the animals before they had time to develop rabies.

The incubation period (the period which elapses between the exposure of a person to a disease and the time he develops the disease) in rabies is exceedingly un-

certain. The disease may develop days after a bite by a rabid animal or it may be weeks before the symptoms appear. It occurred to Pasteur that since the symptoms of rabies were those of disturbance of the nervous system the virus, whatever it was, would be found there in most concentrated form. Pasteur, therefore, opened the skull of a dog dead of rabies under all precautions against contamination by the use of sterile instruments and sterilized glassware. From the medulla oblongata situated at the base of the brain he extracted a particle of tissue. This was ground up in sterile water, and when he injected this fluid under the skin of an animal that animal developed rabies. Next he tried injecting this mixture not under the skin but through an opening in the skull where it came in direct contact with the brain. Animals thus inoculated developed the disease within fourteen days, while with the method of inoculating under the skin the incubation period was variable and uncertain.

Pasteur now concerned himself with discovering a means of attenuating the virulence of the brain tissue of rabid animals. In this tissue he had been unable to identify any micro-organisms but had concluded that one probably was present but too small to be visualized by his microscope. He decided to try the same method of attenuation which he had used with the chicken cholera bacillus,—allowing it to dry out. To do this he removed the medulla oblongata of rabid rabbits and suspended them in small glass jars to dry in a room at a temperature of twenty-three degrees Centigrade. He found that after fourteen days of drying the substance had lost its virulence entirely. He then began by in-

jecting dogs on successive days with the substance dried for fourteen days, then with that dried thirteen days, and so on until they were injected with the brain of a rabbit dead the same day of rabies. Dogs which had been inoculated in this way could now be bitten by rabid dogs and not contract the disease.

Not long after the successful inoculation of animals against hydrophobia had been accomplished a small boy in one of the provinces had been horribly bitten on the face and arms by a mad dog. The family doctor had heard of Pasteur's work, and sent the child with his mother to Pasteur at Paris with a note pleading with Pasteur to try to do something for him. Pasteur had never tried his method on a human being. He was in ignorance as to whether this virus, which when dried for fourteen days was harmless for animals would also be harmless for human beings, or whether humans by successive inoculations would be rendered immune to the virulent virus. The little boy, Joseph Meister, arrived at Pasteur's laboratory in so much pain he could scarcely walk. Pasteur, who was fond of children and had lost three of his own, was much touched. He arranged to have the child and his mother comfortably lodged while he consulted some of his medical friends as to the wisdom of attempting the method, used so successfully in animals, on a human being. His friends pointed out the seemingly hopeless outlook for the boy and advised Pasteur to vaccinate him. That night Joseph Meister received his first injection. The following ten days were anxious ones for Pasteur. The early injections caused the boy no discomfort. Daily he came to the laboratory

and enjoyed having Pasteur show him the laboratory animals. One afternoon he received the last injection of virulent virus, virus which inevitably killed animals not previously vaccinated. That night Pasteur was awake all night dreading to hear it announced that the boy was ill. But the next day the boy was quite well, and he remained so.

After this successful demonstration of its efficacy many individuals appeared at Pasteur's laboratory to be vaccinated. In a small village in Russia nineteen peasants had been bitten by a rabid wolf. The Czar of Russia, hearing of Pasteur's work, sent them to Paris for treatment. Three of them were so horribly bitten that they died of their wounds. Two weeks had elapsed since they had received their wounds, and this made the outlook for the others more serious. Pasteur, to hasten their protection, vaccinated them twice a day until their vaccinations were completed. Fourteen of them returned to Russia and remained well. The case of these peasants received wide-spread attention. The Czar, in recognition of Pasteur's service, granted him the diamond Cross of the Order of St. Anna of Russia.

Pasteur's small laboratory soon became overtaxed by work required in the preparation of anthrax vaccine and the treatment of individuals in the prevention of rabies. The death-rate from rabies had been reduced to one in a hundred. The idea was conceived of founding a large institution, to be called the Pasteur Institute, for the preparation of vaccines and to provide facilities for further research and teaching. A wave of generosity swept over the French nation and over two and a half

million francs were raised by popular subscription, to which were added contributions from foreign countries. On November 18, 1888, this Institute was opened by the President of France.

The work on hydrophobia was the last achievement of Pasteur's fruitful life. After the opening of the Pasteur Institute his health forced him to relinquish the active work to his colleagues and pupils. Pasteur's was a brilliant and imaginative mind, and he possessed a genius for investigating Nature's secrets by resourceful experimentation. By training a chemist, he created a new epoch in medicine, and modern medicine may be said in many ways to have had its beginning in his work. Rarely has the work of a man come to be so fully appreciated during his lifetime as was Pasteur's. He died in 1895 at the age of seventy-three, fully conscious of the great esteem in which he was held by his fellow men. His portrait is reproduced in Figure 27.

The work of Pasteur in bacteriology was stimulated throughout with the idea of making it serve for the cure of diseases and the benefit of mankind. He was less interested in the mere discoveries of the streptococcus and staphylococcus, the germs of blood-poisoning including puerperal fever, than he was in the resulting improvements in surgical and obstetrical technique in the surgical clinic and at the bedside of the parturient woman. His interest was in the cure of hydrophobia rather than in the discovery of its causative germ, which has not yet been isolated. His discovery of the influence of heat on the virulence of germs and of the attenuation due to growth in the bodies of different animals led to

the manufacture of all his curative agents which are true preventive vaccines, and has endorsed and explained the discovery of Jenner. His invention of the process of heating food products at moderate temperatures, which is known as pasteurization, was used by him for the improvement of beer. Its use has been extended to other foods and especially to secure for large cities a milk supply free from pathogenic and other contaminating germs.

Robert Koch

While Pasteur was revolutionizing ideas concerning the causation of disease, and first pointing out the rôle of microbes, a young German, Robert Koch, was living the life of a country practitioner at Wollstein. Koch was born at Klausthal, Hanover, in 1843. After serving as an army surgeon in the Franco-Prussian War, he settled down to the work of a general practitioner but soon developed an interest in bacteriology and availed himself of every spare moment to study bacteria in a small laboratory improvised by partitioning off a part of his office. Beginning in this way Koch was to make important discoveries, and do a great deal for the perfection of bacteriological technique. His first important work was done on the anthrax bacillus, which he succeeded in growing in the watery liquid contained in the eye of an ox. He then devised a method of growing these bacilli under conditions which resulted in their disappearance with the formation of spores. Early bacteriologists had great difficulty in growing bac-

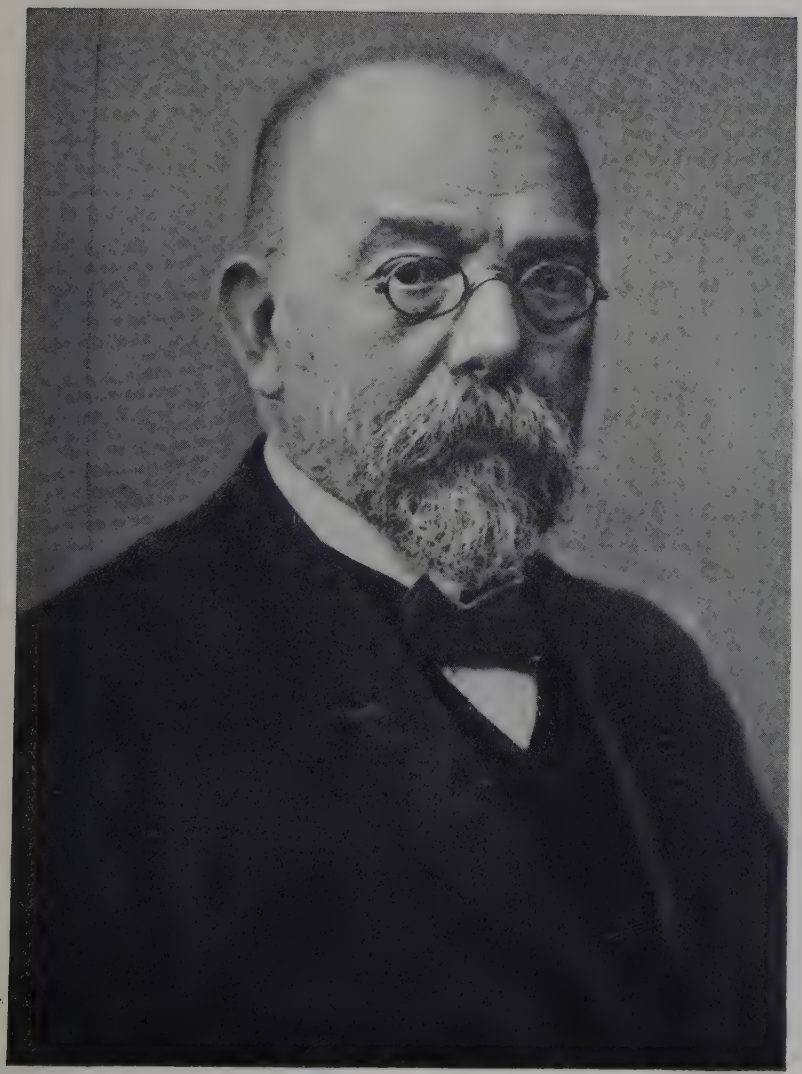
teria in what are called pure cultures, or ones which contain only one variety of bacteria. The culture media first used were liquids, usually a broth of beef, chicken or mutton. When more than one type of bacteria was present in these liquid media it was impossible to separate one from another. Koch one day noticed on the cut surface of a potato numerous small spots separated from one another and different in color and shape. "Fishing" particles from these different spots he found that each consisted of a growth of a different bacterium. In other words, each spot represented a colony containing only one type of bacteria. This suggested to him that if a substance containing different bacteria were spread upon a solid surface the various bacteria would develop into distinct colonies and thus could be separated from one another. To obtain such a solid medium Koch added gelatin to his broths, and in this way obtained a good solid culture medium. This was an advance in bacteriological technique which proved of great value.

It was natural that with the introduction of the germ theory of disease many investigators should turn their attention to the cause of tuberculosis. All efforts to discover an organism which might be responsible for this disease had failed until Koch began the work which was to be the most important achievement of his life. Tuberculosis manifests itself by the formation in the tissues of small bodies resembling millet seeds called tubercles. Koch ground these tubercles up and with his microscope searched them for the presence of some micro-organism. For a long time he was unsuccessful,

but eventually began staining the tissues with various dyes. After many attempts he found a dye which regularly demonstrated in tuberculous tissue a rod-shaped bacterium sometimes straight, sometimes curved and often in clumps. Koch next made an emulsion of tuberculous tissue and injected it into animals. These animals sickened and died and in the tuberculous tissue he found in them Koch was able to demonstrate these same bacilli. He now set himself to the task of growing these bacilli outside of the body. For a long time he failed to find a medium upon which they would grow but finally obtained from a slaughter-house some of the yellow serum which separates from animals' blood after clotting, and with this as a medium he was successful in growing the bacilli although it took fourteen days for them to appear while other bacteria usually appeared within twenty-four or forty-eight hours. Taking cultures of this bacillus, Koch injected them into animals and in a few weeks they died with the characteristic lesions of tuberculosis in which he again found the bacillus which he called the tubercle bacillus. In this way he proved that the tubercle bacillus was beyond doubt the cause of tuberculosis. This work caused him to lay down the rules known as Koch's Postulates which are necessary to identify a microbe as the causative agent of a disease. These stipulate that the micro-organism must be present in every case of the disease, that when cultivated in a pure culture and inoculated into susceptible animals these must develop the disease and that the organism must again be obtained in pure culture from these inoculated animals.

Soon after the completion of his work on tuberculosis an epidemic of cholera developed in Egypt, and Koch with his assistant, Gaffke, went to Alexandria in an endeavor to discover the cause of Asiatic cholera. The epidemic subsided soon after their arrival and before their investigations had shown any result. Koch later went to India where cholera was almost constantly present, and succeeded in identifying as the causative agent a comma-shaped bacillus present in the bodies of cholera victims, and in water contaminated with the bacilli which had been introduced by the addition of the excreta of patients sick with the disease. At this time one of the strong opponents of the germ theory of disease was Professor Max Pettenkofer, a professor of hygiene at Munich. When Pettenkofer heard of Koch's claims concerning the cholera bacillus he asked Koch to supply him with a culture of the organism for study. Koch obliged him, and Pettenkofer undertook the study by swallowing the contents of the entire culture tube. Nothing happened to him. This was a foolhardy thing for Pettenkofer to do, but it illustrated an important phase in relation to disease. Pathogenic organisms are probably so prevalent that if every individual exposed to them acquired the diseases which they cause, few individuals would survive. Contraction of a disease depends, therefore, not simply upon exposure to a germ but on other factors not clearly understood which include the resistance of the individual to a specific germ.

After Koch discovered the tubercle bacillus the world waited expectantly for him to announce the discovery of a method of curing tuberculosis. In 1890 he announced



From a photoengraving in the Collection of The New York Academy of Medicine

Figure XXVIII

KOCH

that he had succeeded in the preparation of a filtrate from cultures of tubercle bacilli which he called tuberculin and which he believed would cure early cases of tuberculosis. This announcement was premature inasmuch as it failed entirely when subjected to trial by the profession. Tuberculin became useful in the diagnosis of tuberculosis but did not prove to be a remedy. This caused great disappointment, and for a while Koch lost caste in the eyes of the profession. This attitude toward him was only temporary however, since he continued to make numerous valuable contributions to medical bacteriology.

Koch was the recipient of many honors during his lifetime. On one occasion the Prussian Government made him a grant of one hundred thousand marks in recognition of his services. He was twice the recipient of the Nobel Prize. In 1891 the Institute for Infectious Diseases was founded in Berlin, and remained under his direction until his death in 1910. At this Institute the former country practitioner was able to work with all modern laboratory facilities with the assistance of numerous pupils, several of whom were themselves to become valuable contributors in this field. Koch's portrait is reproduced in Figure 28.

Élie Metchnikoff

The work of Élie Metchnikoff (1845-1916), who was born in Russia and who worked with Pasteur, discovered the relationship of the living white cells of the blood as opponents and destroyers of pathogenic germs.

This action of the living cell is known as phagocytosis. Metchnikoff also made many experiments on the bacteriology of the large intestine and attributed to the existence of disease-bearing germs in the intestine a distinct influence on the development of the changes characteristic of old age. He studied the bacteriology of lactic-acid fermentation and believed that the formation of acid was the best means of controlling the growth of these noxious germs. He formulated a method of intestinal disinfection by which he endeavored to restore a normal condition in the flora of the intestine by implanting germs producing lactic acid to contend with the ones to be eliminated.

Paul Ehrlich

Paul Ehrlich (1854-1915) was early associated with Koch at the Institute in Berlin. His first studies had to do with the white cells of the blood, and he was able to differentiate the various types by means of their differences in appearance when stained with certain dyes. He subsequently moved to Frankfort where he worked in the pathological institute which was under the directorship of Karl Weigert. Ehrlich's chief contribution was his theory concerning the method in which immunity to disease was established in the plasma of the blood. This theory is complicated but satisfies every criterion necessary to explain the facts concerning acquired and permanent immunity to the poisoning from the toxins of bacteria. It explains the formation of antibodies and the reasons for the curative and preventive

action of serum therapy. It has to do entirely with the chemical processes involved. Ehrlich's work on syphilis will be referred to in detail in a later chapter.

Discoveries in bacteriology came quickly after Pasteur had blazed the way and Koch had improved the technique. Attention can not be called here to every advance that has been made in the past fifty years, but it is interesting to follow somewhat in detail those discoveries which have resulted in the production of therapeutic agents of value in the treatment and cure of disease. In 1880 Carl Joseph Eberth isolated the germ of typhoid fever, and this discovery has been the source of many advances. The work of Widal on agglutinations of bacteria has already been mentioned as improving the facilities of diagnosticating the disease. The discovery of the causative germ has also resulted in a method of preventing typhoid fever. It is found that in certain cases subcutaneous injections of emulsions of dead bacteria will cause a specific immunity against the infections from the same bacteria when actively alive. Typhoid fever is one of these diseases, and inoculation with the dead bacteria has proved a temporary means of making people insusceptible to this infection. This fact was first demonstrated on a large scale in the United States Army, when some twenty thousand men were encamped in Texas, and made a short expedition into Mexico. During these maneuvers which lasted several months not one of the immunized soldiers developed typhoid. Typhoid fever had previously been one of the greatest scourges of soldiers grouped together in large numbers for the waging of war. In

1898 deaths from typhoid fever in the American Army were more numerous than those from wounds inflicted by the Spaniards. The immunity secured by this means is of comparatively short duration and can not be guaranteed for more than two years, although it may be extended to five or six years in unusual cases.

In 1881 Pasteur himself discovered one of the bacteria which causes lobar pneumonia. George M. Sternberg and Albert Fränkel in 1884 made similar discoveries and extended our knowledge of the pneumococcus, and in 1883 Carl Friedländer discovered a bacillus which was exceptionally also a cause of pneumonia. It was not until forty years later that scientists of the Rockefeller Institute produced a true antitoxic serum which, given early in certain types of the disease, has a very active curative power. The work of these same physicians demonstrated the extreme complexity of the types of the germs causative of pneumonias. Friedrich Fehleisen isolated a specific form of streptococcus that is the cause of erysipelas, which disease has also recently been brought largely under the control of an antitoxin. Edwin Klebs in 1883, and Friedrich Löffler in 1884 isolated the germ of diphtheria. Subsequent studies by T. Mitchell Prudden and his students showed that the streptococcus could produce a septic sore throat of great virulence which resembled the true diphtheria. Diphtheria was the first disease to be brought under control by the use of an antitoxin dissolved in the serum of an animal which had been inoculated either with the germs of the disease or with the toxin secured from laboratory cultures of the bacillus.

Emil von Behring, of Berlin, and Émile Roux, of Paris, share the honor of having developed this new form of specific remedy. A further development relating to the prevention of diphtheria by the establishment of a permanent immunity has been made since 1920. It consists of the injection hypodermically of a chemical mixture of the toxin and antitoxin of the disease. When this has been thoroughly applied to the children of a community diphtheria will practically disappear as a cause of death. Recent investigations have proved that as children grow up they acquire an immunity to diphtheria which lasts throughout their life, and the use of this toxin-antitoxin solution hastens the development of this permanent immunity.

The dysentery caused by various bacilli, of which that discovered by Isagiyoi Shiga in 1897, and that by Simon Flexner in 1900, and the more recent discovery of A. M. Bargen, of Rochester, Minnesota, can be controlled and cured in many cases by the use of emulsions of dead bacteria as is done in preventing typhoid fever. The use of dead bacteria for this purpose should be referred to as an inoculation and not as a serum or a vaccine, as, in the looseness of speech not only of laymen but of the profession, is so often done.

Nicolaier in 1884 discovered the bacillus of tetanus, and this disease was early found to belong to the same class as diphtheria. A reliable preventive antitoxin exists and is efficient if injected soon after the infection takes place. The period of incubation of tetanus is of several days' duration and the antitoxin has time to act efficiently in consequence of this peculiarity.

Anton Weichselbaum, of Vienna, recognized the meningococcus in 1887 as the cause of epidemic cerebral spinal meningitis. Subsequent work by Jochmann and Flexner has produced a curative serum which when injected into the spinal canal of patients suffering from the disease causes a rapid improvement in the symptoms. It is necessary to use the remedy in as early a stage as possible, for the disease can not be recognized until it is fully established.

The rôle of insects in the transmission of disease was first convincingly demonstrated by the American physician, Theobald Smith, in his work on Texas fever in 1893. Texas fever is a disease of cattle characterized by fever and anemia, and is transmitted from one animal to another by the bite of a tick, Boöphilus Bovis.

Sir Ronald Ross, of the Indian Medical Service, was impressed by the work of Sir Patrick Manson in proving that the mosquito is the vector of filaria sanguinis hominis, a wormlike parasite, which enters the blood stream and makes its way to the lymph channels, causing blockage and swelling of the extremities. Ross, as had others before him, suspected that the mosquito played a similar part in the transmission of malaria of which Alphonse Laveran, a surgeon in the French Army, had discovered the causative agent in 1880. This organism called the plasmodium consists of a small mass of protoplasm capable of amœboid movement which enters the red blood cells and increases in size until it occupies and destroys the entire blood cell, when it divides into segments which escape from the cell into the blood stream and continue the infection by destroying

other blood corpuscles. For a long time Ross met with failure in his experiments, but finally, working with malarial birds, he found a type of mosquito which contained the plasmodium after sucking the blood of such birds, and was able to demonstrate the plasmodium in the cells lining the stomach of these mosquitoes. By fortunate circumstance while observing a plasmodium in the stomach of a mosquito, he was able one day to see this plasmodium segment, and to watch these segments make their way from the stomach to the salivary glands from which situation they could be easily ejected by a mosquito when it stung its victim.

A type of micro-organism known as the trypanosome was first described by David Grüby in 1843. This organism, much larger than an ordinary microbe, has an undulating body with a flagellum or whiplike projection at one end. In 1894 David Bruce proved that the tsetse-fly disease of Zululand was due to such an organism and was transmitted from the wild animal to cattle by the tsetse fly. In 1901 J. E. Dutton demonstrated the presence of a trypanosome in the blood of victims of African sleeping sickness, and Aldo Castellani later demonstrated the same organism in the spinal fluid of such cases. A chemical drug to be used by injection into the veins has recently been reported, which is a specific remedy against this scourge of Equatorial Africa.

XIV

LISTER

The Growth of Surgery

It is difficult for one of the present generation to picture major operations performed in the absence of an efficient anesthetic, and yet the art of producing insensibility to pain in preparation for an operation was not developed until the middle of the last century. Since ancient times patients had been drugged with different preparations, especially opium, to diminish their sensibility. In the Middle Ages the soporific sponge was introduced, or rather reintroduced, from which the patient inhaled vapors of a number of drugs which were applied to lessen his sufferings. These methods were of course entirely insufficient, and the successful completion of an operation depended upon the speed of the surgeon and the strength of his assistants whose duty it was to restrain the struggling and agonized patient.

The advance in chemistry at the latter part of the eighteenth century included the discovery of hydrogen, oxygen and nitrous oxide gas. Ether was made in the laboratory by the distillation of alcohol combined with sulphuric acid, and chloroform by the action of chlorinated lime on alcohol. These substances were called to the attention of the profession at that time, and Doctor Pearson in Birmingham, England, used ether in

the treatment of asthma in 1785. In London a medical pneumatic institute was founded for the treatment of this disease by the inhalation of various gases. The institute made no progress but its director, Humphrey Davy, noted the effects of the inhalation of nitrous oxide which subsequently came to be known popularly as "laughing gas," and he had one of his wisdom teeth extracted while under its influence. In 1830 Humphrey Davy asserted: "As nitrous oxide . . . seems capable of destroying physical pain, it may probably be used with advantage in surgical operations in which no great effusion of blood takes place." Faraday in 1818 stated in one of his published articles that the inhalation of vaporized ether mixed with air produced an effect similar to that obtained from the inhalation of nitrous oxide. So far as medicine was concerned no attention was paid to this statement.

The general public became more or less accustomed to the effects of nitrous oxide which was used in popular demonstration for the amusement and wonder of the audience when the preliminary stage of intoxication was produced upon any confiding volunteer. A man named Stockman gave such a demonstration in 1821 in the town of Rome, New York, when some small boy got hold of the tank of nitrous oxide, made himself unconscious and did not revive for some time after he was found by the lecturing showman. This opportunity for recognizing the possible usefulness of nitrous oxide gas in the practice of surgery went unheeded.

An unrecognized pioneer in this branch of medicine is to be found in the person of Henry Hill Hickman, of

England. Hickman was inspired to search for a method producing insensibility to pain to be used in his surgical work. He conducted experiments on animals in which he caused unconsciousness by depriving them of air and later by the administration of nitrous oxide gas. Hickman found that he could operate upon his animals even to the extent of amputating their legs without causing pain. He endeavored to draw the attention of the profession in his own country, and later that of the profession in France, to these experiments, but in neither country was he given any attention, or if so, his method was regarded as dangerous. He became broken-hearted and discouraged, and died in 1829 in his thirtieth year.

Credit for the introduction of anesthetics has been the subject of considerable controversy especially as to the claims for priority of Crawford Long, a physician, and William T. G. Morton, a dentist. Crawford Williamson Long was born in Danielsville, Georgia, in 1815, and graduated in 1839 from the University of Pennsylvania. Long began his experiments in company with some of his friends by inducing intoxication from the inhalation of ether. He noticed that while under the influence of this "ether frolic" he often became badly bruised without the consciousness of pain. As the result of one of these frolics held by some young people at a quilting-bee a young negro was forced to take ether against his will. As a result of the struggle he got a larger quantity than was intended, became totally unconscious and did not regain his senses for some considerable time. Doctor Long made further observations upon himself and one of his young medical friends

and came to the conclusion that ether anesthesia could be used with safety for the performance of surgical operations. Doctor Long had the courage on March 30, 1842, to operate under ether on a Mr. James Venable, and removed a tumor from his neck. In the next three years he performed eight other operations under the same conditions. Doctor Long was a young man and did not publish the results of his work, possibly waiting until he could present a longer series of cases.

In 1844 Horace Wells, a dentist in Boston, attended a lecture by a chemist, G. Q. Colton, on the effect of nitrous oxide with the result that he allowed Colton to give him gas the next day while Doctor Riggs, an assistant, extracted a tooth, and thereafter he used nitrous oxide almost daily to render people free from pain while he followed his profession as dentist in extracting teeth. In 1845 he appeared before the Harvard Medical School, but for some reason the demonstration of his method failed. He became depressed and melancholic and eventually went insane.

Morton

William T. G. Morton was a pupil of Wells and also practiced dentistry in Boston. He studied medicine under Dr. Charles Jackson. Morton was aware of the work of Wells, and when his public demonstration with nitrous oxide failed Morton undertook some experiments on animals with ether at the suggestion of Doctor Jackson. On one occasion he gave himself ether to the point of unconsciousness, and finally extracted a tooth

under ether anesthesia. This was done in September, 1846, and Morton continued the use of ether anesthesia in his practice. On October 16, 1846, Morton gave a public demonstration of his method at the Massachusetts General Hospital. The patient was anesthetized, and Doctor Warren removed a tumor before a large audience without any discomfort to the patient. After this, the use of ether as an anesthetic for surgical operations quickly became general, and the prestige of the successful demonstration in the service of Doctor Warren, an influential surgeon of the Massachusetts General Hospital, has resulted in giving Morton the credit which he deserves of having successfully introduced ether anesthesia to medical practice, although Dr. Crawford Long had previously done the same thing in private. It seems hardly necessary to add that Doctors Warren, Jackson and Morton knew nothing of the work of Doctor Long. A portrait of Morton is found in Figure 29.

The anesthetic properties of chloroform were discovered by a Scotchman, Sir James Y. Simpson on November 4, 1847. Simpson introduced chloroform to overcome the after-effects of nausea and vomiting and the unfavorable effects of ether on the larynx which were a prominent feature of its use. Because of the more pleasing odor, the greater rapidity with which chloroform produced anesthesia, and the quicker recovery of the patient from its effects, chloroform seemed superior to ether as an anesthetic. It was used very generally in childbirth, but its more dangerous features in regard to the heart have made it unpopular for general surgical

From a steel engraving in the Collection of The New York Academy of Medicine

Figure XXIX

MORTON

uses. The recent refinements in the administration of ether also have diminished the objections, and at the present time ether has become the drug more generally used.

Sir James Simpson was an obstetrician, and he encountered great opposition because of his suggestion that chloroform be used to diminish the pains of childbirth. The opposition came from the Scottish Church. These theologians insisted that its use was wicked because the pains of childbirth were a part of the "primeval curse on women." A heated controversy occurred in which Simpson was victorious because his opponents were ridiculed by his quotation of the twenty-first verse of the second chapter of Genesis that before the Maker of the Universe took a rib from Adam for the creation of Eve, He caused a deep sleep to fall on Adam.

Many improvements have recently been made in the use of anesthetics. New drugs have been introduced; the combined use of ether with oxygen, of nitrous oxide gas with oxygen, and the latest discovery of ethylene, have rendered surgical anesthesia much less of a terror to patients than it once was. The discovery of cocain by Carl Koller in 1884 added a new method known as local anesthesia. Cocain also proved to be not only dangerous in large doses but a habit-forming drug, and many synthetic substitutes have been introduced which have largely taken its place. The discovery of anesthesia has made possible the performance of many operations which otherwise could not be undertaken because of the length of time and the intricacy of the mechanical procedures which are required.

Joseph Lister

One of the earliest and most striking benefits of an understanding of the meaning of bacteria in relation to medicine came from the application of this knowledge to surgery. Joseph Lister was the first to grasp the significance of the rôle of bacteria in the formation of pus (suppuration), and introduced a revolution in surgical procedure. With Ambrose Paré and John Hunter, Lister ranks as one of the three greatest surgeons in history.

Lister was born at Upton near London on April 5, 1827. His father, Joseph Jackson Lister, was a wine merchant much interested in matters of science. He was the inventor of the achromatic lens, an invention which resulted in the modern microscope. Between the father and son there existed an enduring bond of sympathy and understanding which led to a voluminous correspondence in which the son explained his work and its problems, and often received encouragement and wise advice in return. The Listers were Quakers, and Joseph was brought up in the kindly and unostentatious atmosphere of that sect. Upon his marriage he automatically left the Society of Friends as any Quaker does who marries "out of Meeting." Throughout his life in his correspondence with members of his family he continued to use the familiar "thee" as a form of address.

Lister obtained his medical education at the University of London. Upon completion of his course his professors obtained for him the position of house surgeon to James Syme at Glasgow. Syme, who was

at this time one of the most celebrated surgeons in Great Britain, and a bold and skilful operator, was one of the first to substitute excision of a diseased joint for amputation of the limb, the practice generally followed until then. He was also one of the first of the European surgeons to adopt ether anesthesia, and later was quick to make use of the antiseptic methods of his pupil, Lister. Lister showed a bent for research and investigation from the first. His earliest investigations were concerned with the processes of inflammation. In one of his earliest papers he describes the effects of heat and other irritants upon the blood-vessels of the web of the foot, or of the mesentery of the frog, which induced a condition analogous to inflammation with its redness and swelling. He showed futher that the constriction and dilatation of the blood-vessels were governed or controlled by the nerves and central nervous system. He made further researches on smooth or involuntary muscle and on the muscular fibers which dilate and contract the pupil of the eye. During his developing of an antiseptic method he sought a type of ligature which would be absorbed by the tissues in place of the unabsorbable silk thread. For this purpose he adopted catgut, a substance obtained from the submucosa, one of the layers of the intestine, of sheep.

Before the introduction of antisepsis by Lister the surgical wards of hospitals in the middle of the last century were usually overcrowded and often poorly ventilated. The nursing was in the hands of ignorant and often rough women, since nursing was not undertaken by women of education and refinement until a

training school for nurses was founded by Florence Nightingale at St. Thomas's Hospital in London in 1860. The surgeons and dressers upon entering the wards removed their coats and donned some old and soiled one, respected for its years of service. In the buttonholes of these coats were usually several silk threads or ligatures ready to the hand, after an application of beeswax, whenever a stitch was needed. One or two jugs of water were ready in which to rinse the instruments or marine sponges as the surgeon went from bed to bed doing his dressings. Naturally under these conditions no wounds were clean, and pus formation was so universal that it was considered a necessary part of the healing process.

In addition to the saturation of the wounds with pus giving rise to what the old surgeons called a "good healthy surgical stink" there were four diseases which took great toll of the individuals who entered the surgical wards and from which the wards were never entirely free. These were septæmia, a condition due to the presence of pathogenic bacteria in the blood stream; pyæmia, a similar condition with abscesses disseminated throughout the body; hospital gangrene, characterized by mortification of the tissues; and erysipelas. The mortality in various hospitals ranged from twenty-four to sixty per cent. of all operations. At the time the most common operation was that of amputation. Abdominal surgery was very seldom done although Ephraim McDowell, an American surgeon living on the Kentucky frontier, had successfully removed an enlarged ovary in 1809, and had had similar successes in

several cases subsequently, and Thomas Keith and Spencer Wells had been similarly successful later in England.

The reasons for the development of these conditions and diseases in hospital wards were not understood. The prevailing conception was that they were introduced into the wounds by the air. The causative agent contained in the air was thought to be some unknown poison, or more probably one of the gases contained in the air, possibly oxygen.

Lister had long been impressed by the difference in the course of healing of simple and compound fractures. In a simple fracture the skin remains unbroken. In a compound fracture the skin is broken and torn. Cases of simple fracture, although the bones were badly crushed or broken, never suppurated or developed hospital diseases, but almost every case of compound fracture became infected and was liable to develop erysipelas or one of the other hospital diseases. The difference in the course of compound and simple fractures emphasized in the mind of Lister the already often acknowledged fact that the contamination of the wounds came from outside sources, probably the atmosphere. Early in his career he began an attempt to find a technique which would exclude this contamination from the outside. His aim was not so much to overcome suppuration already established in wounds but to prevent its occurrence, particularly in operative wounds. His attention was called to the work of Pasteur on fermentation, spontaneous generation and the diseases of silkworms, and he immediately grasped the significance of

bacteria as related to his own problem. It must be remembered in this connection that even the French surgeons to whom Pasteur's work was naturally more familiar at this time had made no serious application of it to their own art.

Lister first sought a substance which, if applied to wounds, would kill the bacteria present without serious injury to the tissues, and at the same time prevent the entrance of other bacteria from the outside. Carbolic acid seemed to him to possess qualities which promised best to fulfill these requirements. A French pharmacist, Jules Lemaire, had been the first to call the attention of the profession to the properties of carbolic acid, and had written a book explaining its uses. Lister, however, when he began his investigations was ignorant of Lemaire's work, and had had his attention directed to carbolic acid by its successful use in the disinfection of sewage at Carlisle. Carbolic acid was supplied in liquid form or in the form of crystals soluble in twenty parts of water, or to any extent in oil. The watery solution could be diluted to any desirable strength beyond one in twenty. The method first adopted by Lister in treating compound fractures was to swab out the wound with a piece of lint soaked in carbolic acid, held with forceps. After this another piece of lint saturated with the acid was applied over the wound and for a short distance on all sides of it. This in turn was covered with a piece of block tin fastened with adhesive plaster. His hands and instruments were cleansed and soaked in various dilutions of carbolic acid before he began his work. This form of dressing for wounds proved unsatisfactory be-

cause the strong acid caused considerable necrosis, or death, of the wound tissues and the adjacent skin.

From then on Lister continually experimented to find an ideal dressing for wounds. For a period he used putty soaked in a solution of carbolic acid as a dressing; later he experimented with other antiseptics such as the sublimate and the cyanide of mercury and boric acid. The dressing which he finally adopted was several layers of gauze impregnated with the double cyanide of mercury and zinc. These experiments with various types of dressings continued over a period of years.

With the introduction of the germ theory the atmosphere was considered the most important vehicle for the transfer of pathogenic or disease-producing organisms. When people saw the innumerable motes in the path of light-rays directed through a darkened room they considered that the bulk of these might be made up of bacteria. Lister therefore felt that the air in the operating-room must be purged of its bacteria by some means. To accomplish this he began the practice of spraying the vicinity of the operating field with carbolic acid. At first, he used a hand atomizer with the ordinary rubber bulb. Later, more complicated hand pumps were used until, finally, a steam atomizer was adopted in which an alcohol lamp applied to a solution of carbolic acid vaporized it. In this way the air of the room and even its walls became dampened with the carbolic vapor. This method was adopted by all surgeons who became convinced of the truth of Lister's work and was used at the time in hospitals all over the world, and the operating premises always reeked with carbolic.

But this procedure did not remain long in vogue. The discomfort it caused the surgeon and his assistants can be easily appreciated but, more than this, it often made them actually ill and resulted in the development of nephritis.

Lister recognized later that the air was a much less important factor than he had at first thought, that ordinarily the pathogenic bacteria present were few in numbers and that the tissue fluids were quite capable of destroying occasional bacteria entering from the air. The dirt entering accidental wounds and the transference of bacteria from the wound of one patient to another by contaminating instruments was found to be a much greater source of danger than the air.

A description of Lister's operative procedure as he practiced it in later years is given by his biographer, Sir R. J. Godlee in his *Life of Lister* as follows: "When everything was precisely in the most convenient position, the patient was brought in. The seat of the operation had not been specially cleansed. 'It is not needful,' he said, 'to apply an antiseptic lotion for hours together, as is sometimes done, a few minutes action of the 1 in 20 carbolic lotion is really sufficient, while its long continued operation sometimes produces troublesome irritation.' This simple preparation was often performed whilst the chloroform,—it was always chloroform, not ether,—was being administered. Lister deprecated the use of soap and water or anything that would remove the greasy matter of the skin, because carbolic acid has a powerful affinity for the epidermis, penetrating deeply into its substance, and it mingles with the fatty materials

in any proportion. Then he took off his coat, turned up his shirt-sleeves, pinned an ordinary huckaback towel over his waistcoat (for his own protection, not that of the patient), and washed his hands in 1 to 20 lotion, or even what he called 'the strong lotion' (1 to 20 carbolic acid in 1 to 500 sublimate lotion), an ordeal that few of his adherents could endure. Towels wrung out of 1 to 20 carbolic acid lotion were arranged over thin mackintosh round the seat of operation. He wore no mask or gloves. Silence was supposed to be maintained as long as the wound was exposed, but the rule was by no means strictly adhered to.

"During the operation, which was seldom short, for Lister was a slow operator, the hands of every one concerned were frequently dipped in 1 to 40 lotion. The sponges when soiled were washed in cold and hot water, and replaced in 1 to 40 lotion. Thus although they were forcibly wrung out before being used again, a small amount of carbolic acid was constantly conveyed to the wound, and, as a safeguard against any gross contamination owing to the carelessness of assistants or nurses, he used to wash the wound with 1 to 40 lotion before sewing it up. But he doubted the necessity of this precaution and sometimes omitted it. Bleeding vessels were tied with his own specially prepared sulphochromic catgut, brought dry to the house and simply steeped for about half an hour in 1 to 20 lotion. The sutures were silver wire, silkworm gut, or sometimes fine silk or catgut. They were only rendered aseptic by means of carbolic acid. The dressing was a thick pad of cyanide gauze covered by a mass of salicylic wool.

The part of the gauze next the wound was wrung out of 1 to 40 carbolic acid lotion."

The simplified operative procedure thus described represented Lister's method arrived at after years of experiment and change. But from the first Lister's efforts at antisepsis began to show their value. In his own wards at the Royal Infirmary in Edinburgh where he had been called to the Chair of Clinical Surgery at the age of forty-two, the incidence of hospital diseases rapidly declined and the number of wounds healing without pus formation steadily increased, operations were undertaken with much greater confidence and types of operation tried which were previously considered too hazardous to attempt. Lister's experience as an innovator in medicine was not exceptional. In the first place the nature of his aims was misunderstood. While he himself always emphasized that his method of antisepsis was simply an effort to prevent the entrance of bacteria into wounds, many looked upon it only as the use of a new medicament in the form of carbolic acid, and the principles of antisepsis escaped them altogether. Many of the older surgeons refused to see the advantages of the new over the old method and even tried to prove the advantages of the latter by statistics. Lister's method could not fail to impress the majority of thinking men in his profession, and his fame increased steadily. Recognition came a little more slowly in his own country perhaps than it did in others. Several of the German surgeons quickly became ardent advocates of the antiseptic method, among them Karl Thiersch, of Munich, remembered for his improvements

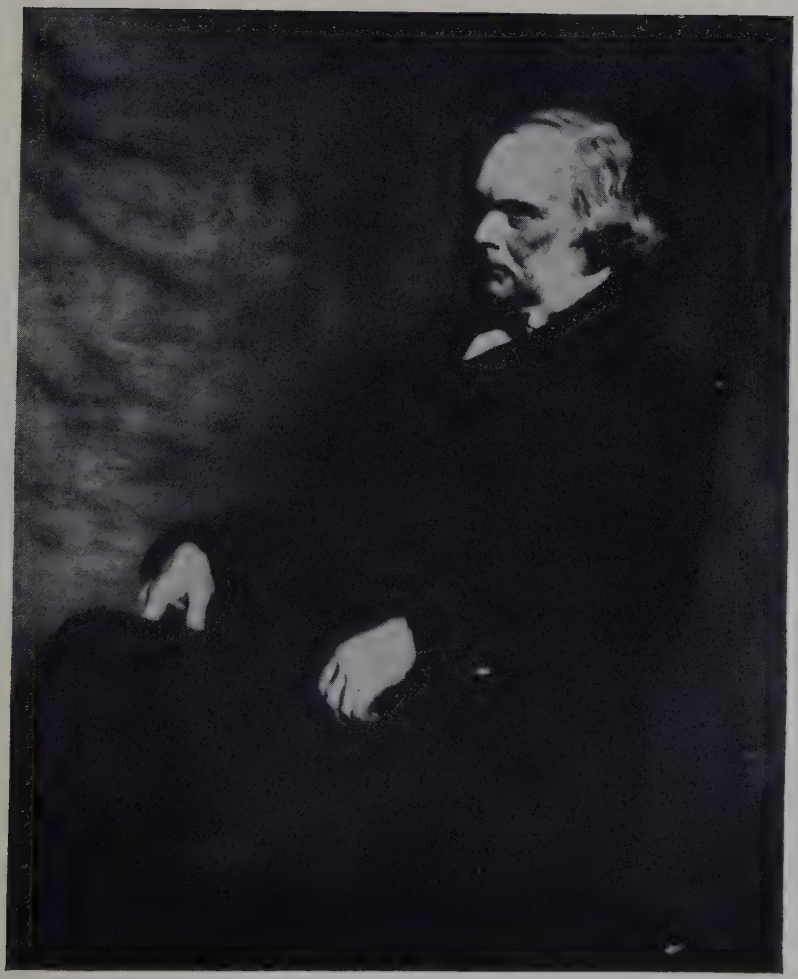
in the method of skin-grafting; Richard von Volkmann, of Leipzig; and Theodor Billroth, of Vienna, a pioneer in surgery of the alimentary tract, who was the first to excise the larynx, to resect the esophagus and the pyloric end of the stomach. In France, Lucas-Championniére, expert in the surgery of bone, strongly advocated the method, and in America it was quickly taken up and successfully applied.

Once the value of his work was appreciated in England and abroad, Lister became the recipient of many honors. Going abroad in 1875 he was received with great deference by prominent medical men in different countries. At Leipzig he was given a dinner by some three hundred physicians and medical students, and toasted in the most flattering terms. In 1877 he was called to the Chair of Clinical Surgery at King's College, London, to succeed Dr. William Fergusson. Fergusson at the time was one of the most prominent surgeons in London and a most skilful operator. He had been influential in establishing the new conservative surgery, substituting excision of joints for the then too ready resort to amputation by most surgeons. Lister left Edinburgh with reluctance and in the face of the protests and regrets of the Edinburgh students and faculty, but he always felt himself a Londoner, and that London was his real home. At London he lectured to much smaller classes than he had at Edinburgh, and he never acquired a large private practice. Nevertheless his time was more than taken up. His opinions were constantly sought, and he was frequently called upon for addresses on various topics. He did much

work in behalf of medical education, and used all his influence to oppose fanatic antivivisection legislation introduced into Parliament. In the meantime he spent a great deal of time in his laboratory in private researches, dictating his observations to the ever-helpful Mrs. Lister who was the daughter of his former preceptor, Doctor Syme.

In 1883 Lister received a baronetcy, and in 1897 by elevation to the peerage became Lord Lister. Upon receipt of this honor he received the following letter from S. Weir Mitchell, the noted American neurologist: "I certainly never expected to be able to address a physician as a Peer of the Realm. That you should have been chosen to add distinction to the peerage has given the utmost pleasure to many on this side of the ocean. Surely in all the great story of surgical progress there has been no man who has given to his fellows a gift so great as that which came from your hand. It is a little thing,—a title,—but if it represents to you the gratitude of the world, it acquires larger meaning than if it had been given even for service, however great, to your own country alone. It—that which you did—was a thing so past comparison great and far reaching, that, except as to our own gift of anesthesia, there is nothing in medical annals with which to compare it. Let me add my personal felicitations, and say how much pleasure it gives me to feel that our profession is at last receiving the long-delayed recognition, the absence of which has for so many years surprised us. I hope to live to see some physician win as well deserved a peerage."

Lister died at the age of eighty-five on the tenth of February, 1912. He was buried at his own request by



From a photograph in the Collection of Archibald Malloch, M.D.

Figure XXX

LISTER

the side of Lady Lister in the West Hampstead Cemetery, but a plaque was erected to his memory in Westminister Abbey. The portrait of Lord Lister, which is reproduced in Figure 30, shows him in his later years when he enjoyed the gratitude of the world and the admiration of the profession for his discoveries in practical surgery. Personally Lister was a kindly, mellow gentleman, an interesting lecturer but never oratorical or dramatic. His acquaintance was large, but his intimates were few. His life was filled with work and ordinarily his days held few diversions, but on vacations he found great enjoyment in fishing and the study of the lives and habits of birds. From the Listerian method of antisepsis has developed the modern method of aseptic surgery. Both achieve the same end, the exclusion of septic organisms, but by different methods. Lister accomplished this aim by the use of chemical disinfectants, the present-day surgeon relies chiefly on heat as the sterilizing agent.

At present the ideal place for an operation is the operating-room of the modern hospital. This room is tiled, well-lighted and can be easily aired. The floors and walls are usually in white, the furniture is metal, there are no corners or crevices where dust may collect, and the whole may be cleaned and scoured. Instruments are boiled, the gauze dressings, sheets, towels and gauze pads which have replaced sponges, are sterilized by steam under high pressure. The surgeon wears sterilized linen overalls, cap and mask. He scrubs his hands with soap and chlorinated lime, soaks them in some antiseptic, and then puts on sterilized rubber gloves. The skin at the operative site is painted with iodine, the oper-

ative field is surrounded with sterile sheets and towels. The wound on completion of the operation is covered with several layers of sterilized gauze which is changed only as frequently as the drainage of the wound requires. A technique of this character requires constant intelligent supervision and the most faithful and conscientious attention from each and every member of the operating staff. When in his later days Lister saw this complicated method evolved from his own simpler procedure he was inclined to consider that his successors gained very little over his more simple procedure by such painstaking and complicated effort.

Since the introduction of an antiseptic or aseptic method, surgery has made rapid progress. In conditions where suppuration or abscess formation is already present, the abscess may be evacuated whether in the extremities or in the hollow parts of the body without danger of carrying additional infection into the body by means of contaminated hands or instruments. The abdominal cavity, which fifty years ago was explored only rarely and with great hesitancy, is now opened without trepidation for the removal of infected organs such as the appendix or the gall-bladder; parts of the stomach or intestines are resected in the presence of tumors or ulcers, and stones are removed from the bladder by the abdominal route. As abdominal surgery has improved and progressed similar progress has also been made in the surgery of bones and joints, in that of the cranial and thoracic cavities, and in special fields such as the nose and throat, the eyes and the genito-urinary tract.

XV

GORGAS

The Story of Public Sanitation and Preventive Medicine

The outstanding feature of medicine in the twentieth century has been the organized effort on the part of civilized countries to prevent disease. This effort had of course been initiated before the beginning of the present century, but it has been during the past twenty-five years that this aim has been pursued with an enlightened energy which has resulted in gratifying success. Civilized countries now guard themselves against the importation of infectious diseases by the inspection of entrants and the quarantine of those ill or suspected of being ill. The water supply of cities and towns is protected against contamination. Disposal of sewage is accomplished in municipalities by improved methods in sewer construction, and in rural communities by the construction of sanitary cesspools.

In every enlightened state and city in the world the health of the community is guarded by some supervising agency or board of health whose duty it is to prevent disease. In this way it becomes compulsory for physicians to report cases of communicable diseases and such cases are quarantined or placed under supervision to prevent the spreading of their disease to others. Certain foods are subject to inspection before they come

into the hands of the consumers. This applies particularly to meats and fresh fruits, and more especially to milk. The production and distribution of milk is subjected to rigid scrutiny. At the dairy scrupulous cleanliness is insisted upon, the herds are inspected, and cows suffering from disease, especially tuberculosis, are eliminated. The workers in the dairy are examined to see that they have no disease or that they are not carriers of the germs of diseases such as typhoid fever. It is required that the milk at the time it is distributed to the consumers shall not have an excessive number of bacteria present, and to gain this end careful refrigeration is obtained from the farm to its destination, and in addition pasteurization by the application of a moderately high temperature for a short period of time is also at times insisted on. This control of the milk supply has been one of the important agencies in the striking reduction in infant mortality in the last twenty-five years.

Dairymen are not the only ones subjected to periodic physicial examinations, but all food handlers, such as waiters and cooks in public eating places, must also receive certificates at stipulated intervals that they are free from communicable diseases. The authorities also supervise the conditions under which people work. Many countries forbid the employment of children in factories and mines although much legislation is still needed to control this evil satisfactorily. Proper ventilation and lighting of working premises are often required by the State, and it is insisted upon that the workman be safeguarded against injury resulting from

the hazards of his occupation such as poisoning by the heavy metals and lung diseases from the inhalation of dust.

This is a very brief summary of some of the activities undertaken by civilized communities to promote health and to prevent disease. Such activities have resulted in gratifying progress in many directions. As regards the United States the average expectation of life in 1901 according to the Bureau of Public Health was 49.24 years, while in 1920 it was 54.9 years, an increase of approximately six years. In 1900, 1755 out of every 100,000 persons died, while in 1921 the death-rate was 1163.9 per 100,000, a decrease of 34%. In 1900 the death-rate of infants under two years of age from intestinal diseases was 108.8 per 100,000, in 1921 it was only 41.9. In addition to this decrease in infant mortality from diarrheal diseases there has been a striking reduction in the deaths from typhoid fever and diphtheria, and most striking of all in deaths from tuberculosis, the rate of which per 100,000 of population in 1900 was 201.9 and in 1922 was 97.0.

The decrease in deaths from the three latter diseases has resulted from improvement both in measures of prophylaxis and in treatment. In diphtheria the isolation of the patient and the administration of diphtheria antitoxin to him and of prophylactic doses to those who have been exposed to his infection have resulted in reduced incidence of the disease and in the mortality, while the recent introduction of a protective inoculation composed of a mixture of toxin and antitoxin promises eventually to eliminate the disease entirely. Reduction

of the incidence of typhoid fever has resulted from improvement in sanitation, from the safeguarding of water and food from contamination, and by the use of typhoid vaccination first introduced by Sir Almroth Wright in the English Army. Tuberculosis has been successfully combated by intensive public education explaining to the people the nature of the disease, the meaning of Koch's discovery of the tubercle bacillus and its conveyance from one person to another, and by the open-air method of treatment advocated and so successfully applied in this country by Edward Livingston Trudeau.

It has been referred to above, but will bear repetition, that the regulations of health and the efforts to control infectious diseases do not always meet with a cordial cooperation from the lay public. It is a paradoxical fact that this opposition is often greatest in the most democratic countries. In the United States, for instance, there is a vociferous minority which objects to interference by any govermental agency with its individual judgment and personal rights, when the question of health and choice of medical treatment is concerned. The only solution of the problem is to be found in some process of education, but such methods are slow and the machinery of the profession is not organized for the purpose, nor is it sufficiently financed for an efficient campaign.

In the meantime the antivaccinationists and similar committees and associations are active in an attack against the use of "diseased pus" (vaccine) and "poison germs" (typhoid inoculation), for example. They are

able to circularize similar untrue and insidious propaganda against measures of preventive medicine and those for the improvement of sanitation. The regular physicians have an influence with the families they attend, but they are too busy to spread any information to a wider circle. These same physicians have often been chagrined and have resented the requirements of health boards both municipal and state in regard to the reporting of cases of communicable diseases. The profession is now generally in sympathy with the ideals of the leaders in matters of public health although individual opposition will crop up from time to time. The success of such active measures depends still upon a constant attack against inherited prejudice and real ignorance.

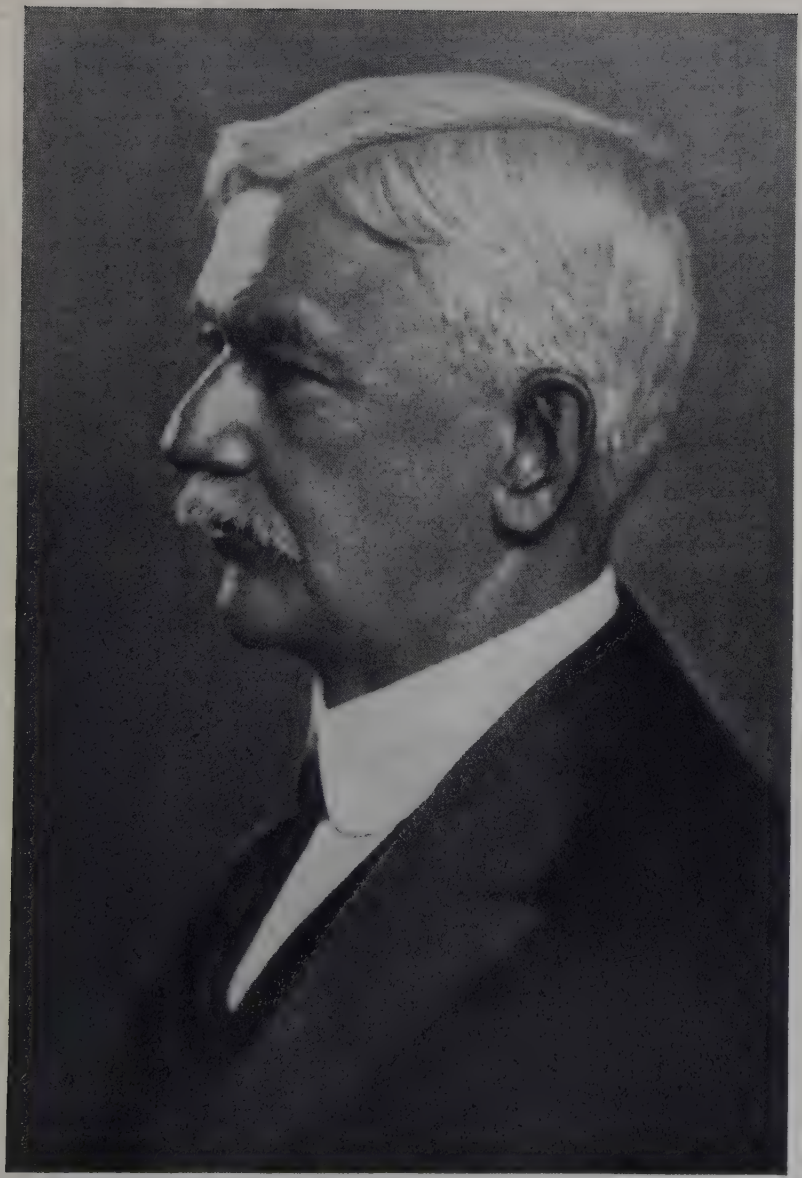
William Crawford Gorgas

The most impressive illustration of the efficacy of organized effort in preventive medicine and sanitation was the construction of the Panama Canal. The foundations for the accomplishment of this work were laid by the American Army surgeons in the occupation of Cuba after the Spanish-American War in 1898. At that time Havana was one of the most unhealthy cities in the world, partly because of the high incidence of yellow fever and partly because of the prevalence of typhoid fever. Sanitary conditions in the city were execrable. Streets were unpaved, mud-holes were everywhere, carcasses of dead animals remained for days in the streets, housewives disposed of their garbage by simply dumping it into the streets where it ac-

cumulated. The sanitary work of the army was in charge of Major William Crawford Gorgas, whose portrait is reproduced in Figure 31.

Gorgas with the help and sympathetic understanding of his commanding officer, General Leonard Wood, undertook to clean up the city. In a few months conditions in Havana were entirely changed and it had become cleaner than the average American city. Gorgas had been under the impression that yellow fever was a filth-born disease. With the cleaning of the city he expected that yellow fever would disappear. He was encouraged in this idea when for several months the death-rate from yellow fever fell to an unusually low level. The following year, however, the influx of Spanish immigrants to Cuba was soon followed by a recurrence of a severe epidemic. Havana remained a clean city but yellow fever thrived in the face of it. Immigration, which because of the war had been reduced, now resulted in the introduction of numbers of persons who were not immune to the disease. With the introduction of these non-immunes yellow fever again flared up. The problem of yellow fever had not been solved by the introduction of measures of civic cleanliness. Therefore Surgeon-General George M. Sternberg appointed a commission of army surgeons to investigate the disease. The commission was headed by Dr. Walter Reed, who was assisted by Drs. Aristides Agramonte, Jesse W. Lazear and James Carroll.

The number of theories as to the cause of yellow fever prevalent among the natives was legion. The commission considered the problem from two angles: first, that



From a photograph in the Collection of The New York Academy of Medicine

Figure XXXI

GORGAS

it was insect-born; second, that it was transmitted by fomites, such as the dejecta, or articles coming in contact with the sufferers from the disease. A Cuban physician, Dr. Carlos Finlay, had preached for years that the vector of yellow fever was a particular variety of mosquito, the stegomyia. Though he had attempted numerous inoculations by allowing this mosquito to bite individuals, he had never succeeded in causing the disease. Gorgas and other army surgeons had frequently listened to Finlay, but had not been impressed by his theory. Dr. Henry L. Carter of the United States Public Health Service was stationed in Cuba. Carter had had a large experience with yellow fever in the Southern States. He had noticed that when yellow fever developed in a community a period of twelve to twenty-one days elapsed between the outcropping of a series of new cases. Reed had had his attention called to the case of a soldier who had developed yellow fever after he had been confined for thirty days in a military prison. None of the other inmates had had yellow fever, and it seemed probable therefore that the disease had not been contracted by contact with other inmates. This inclined Reed to investigate the problem from the standpoint of insect transmission. Availing himself of Finlay's theories concerning the stegomyia mosquito and Carter's observation, he adopted as a working theory the idea that the mosquito did not transmit the disease immediately from patient to patient, but that the elapse of a period of from twelve to twenty-one days was necessary before a mosquito which had bitten a yellow-fever victim could transmit it to another individual.

This theory could only be proved or disproved by carrying out experiments on volunteers. Reed himself volunteered but was dissuaded by his associates because of his age and the necessity for his returning to the United States on other work. Volunteers were obtained who were willing to be bitten by mosquitoes which had previously bitten yellow-fever patients. The results at first were entirely negative. Later Doctor Carroll allowed himself to be bitten by an infected mosquito and developed the disease. He recovered but with so much impairment of health that he died two years later. Next Doctor Lazear was bitten and developed the disease and died, and Doctor Agramonte was also given the disease in the same manner and recovered. This seemed definitely to sustain the mosquito theory, but it was not understood why the inoculations sometimes failed. Reed then established an experimental station to carry out further investigations. Several army privates offered themselves as volunteers and these were joined by some Spanish immigrants who were willing to be experimented upon for two hundred and fifty dollars.

The first to volunteer was Private John R. Kissinger. He was first bitten by a mosquito which had bitten a yellow-fever patient on the fifth day of the disease. Nothing resulted from this bite, but on the second experiment he was bitten by five mosquitoes which had bitten yellow-fever patients in the first three days of their disease. After these bites he developed the disease but recovered although he has been an invalid ever since. These experiments established beyond a doubt that the

stegomyia fasciata was responsible for the transmission of yellow fever and that to transmit the disease it must bite a yellow-fever patient in the first three days of his illness, and that a period of twelve days or more must elapse before it can transmit the disease to another. Having demonstrated the transmission of yellow fever by the mosquito, the commission next sought to determine whether it might also be transmitted directly from one individual to another. For this purpose three volunteers were obtained who slept for nineteen nights in the pajamas and bedclothes previously used by yellow-fever patients, and soiled by their vomitus and other dejecta. These volunteers remained perfectly well.

Walter Reed and his commission having proved that the mosquito was the agent in the spread of yellow fever, it devolved upon Major Gorgas to rid Havana of them. The difficulty of such a task may be imagined, but Gorgas accomplished it. The stegomyia might be called a domestic mosquito. It prefers for its habitat human dwelling-places and likes to lay its eggs in clean water. Gorgas instituted a vigorous campaign embracing the screening of houses, the cleaning-up of vegetation within two hundred yards of dwelling-places, and the pouring of oil on any collection of water. The campaign was so thorough that a card index was kept of all utensils which might hold water and breed mosquitoes on the premises of each citizen. Regular visits were made by inspectors to investigate the condition of these utensils. The result of these measures was a steady decline in the incidence of yellow fever and malaria as well. A day came in 1901 when there was not

a single case of yellow fever in Havana for the first time in its history.

Panama was known as the White Man's Grave. The French had attempted to build a canal across the Isthmus and had signally failed, largely because of the appalling death-rate from tropical diseases among the workmen. When the United States began the work of building a canal Gorgas was sent as chief sanitary officer with the canal commission. Despite his sensational work in Cuba the commissioners at first gave him little encouragement, even laughed at the mosquito theory, and so restricted him in his work that his efforts were almost futile. An epidemic of yellow fever was not long delayed and caused a panic among the workmen and wholesale desertion of the Isthmus. The authorities at Washington, finally convinced that control of tropical disease was the sine qua non of the success of the enterprise, gave orders that Gorgas was to have his way. Gorgas now instituted the same measures which were followed in Cuba. The Isthmus was cleaned up and kept clean, modern sanitary laws were applied to the supply of drinking water and to the disposal of sewage, and finally a successful campaign was waged against mosquitoes. Yellow fever quickly disappeared, the incidence of malaria was reduced more slowly but just as surely. In 1914, ten years after Gorgas began his work, the death-rate in the Canal Zone for one thousand of population was 6 as compared with 14.1 per thousand in the United States. The White Man's Grave had become the most healthful spot in the world. This triumph in preventive medicine is one of

the proudest chapters in medical history. Of the actors in it the names of Jesse W. Lazear and James Carroll are now enrolled in the list of medical martyrs. This list contains the names of numerous men who died of the diseases which they were studying, among them Alexandre Yersin and Hermann F. Müller who died of bubonic plague; Tito Carbone, of malta fever; Allen Macfadyen, of typhoid fever; J. E. Dutton, of relapsing fever; Howard Taylor Ricketts, of tabardillo, or typhus fever; Thomas McClintick, of Rocky Mountain fever; and Hideyo Noguchi and Adrian Stokes of yellow fever.

Dr. Walter Reed did not survive very long the successful completion of the work of his yellow-fever commission but died two years later at the age of fifty-one from appendicitis. In addition to his work on yellow fever he had, with Victor C. Vaughan and Edward O. Shakespeare, as members of a commission investigating typhoid fever during the Spanish-American War, demonstrated the transmission of this disease by flies. The large United States Army Hospital at Washington, D. C., the Walter Reed Hospital, now stands as his memorial.

Major Gorgas, later Major-General Gorgas, completed his work at Panama and retired from the army. He then undertook a series of investigations of an epidemic form of pneumonia among the miners of the Rand in South Africa, for the British Government, and of yellow fever for the Rockefeller Foundation in South America. Gorgas was the son of a Confederate soldier. He was born in 1854, a native of Alabama, and was compelled to obtain his medical education under finan-

cial embarrassment. He graduated at the Bellevue Hospital Medical College in New York in 1879 and joined the Medical Corps of the army soon afterward, in which service he rose to the top and was surgeon-general during the World War. At his death in London in 1920 his funeral services were conducted by the British Government at St. Paul's Cathedral with all the ceremony accorded to one of her own great warriors or statesmen.

The existence of hookworm was early proved to be the cause of tropical or miner's anemia. It was first described by Dubini in 1843. Its presence on the American continent was first made known by Captain Bailey K. Ashford, who was stationed in Porto Rico in 1900 shortly after the taking over of the sovereignty of that island by the United States. Doctor Ashford has remained in Porto Rico, and was instrumental in demonstrating in that country the usefulness of employing an extensive campaign against disease in the interest of public health. The variety of hookworm discovered in Porto Rico was found to be distinct from that found in southern Europe, and to be very largely distributed on the mainland. Under Doctor Ashford's direction about a third of the population were treated for this infection during the years 1903-1904, and the epidemic of chronic anemia was controlled with a reduction of more than ninety per cent. in mortality from that cause. The American Medical Corps had previously removed smallpox from the island by a campaign of universal vaccination.

The discovery of hookworm disease throughout the

Southern States of the American Republic led to the formation of a commission under the financial support of the Rockefeller Foundation. The duty of this Commission was that of exterminating hookworm so far as possible. This Commission later developed into an international Health Board, and under the able administration of Mr. Wickliffe Rose has extended its labors to include a campaign against malaria, and enlarged its field of activity to many foreign countries. In the years 1910-1912 nearly four hundred thousand persons were treated for hookworm in the Southern States, and the work is still going on in increasing activity. The last stand of yellow fever on the west coast of Africa is under attack from this Board, and unfortunately has claimed as victims two of the most devoted scientists who labored in this field, both of whom died within the last year of yellow fever. Hideyo Noguchi, who did much to bring under control the yellow-fever nidus in Guayaquil, Ecuador, and whose recent discovery of the bacterial cause of infectious trachoma added a fine luster to his name, was lost to scientific medicine in the performance of his voluntary duty. Adrian Stokes, a young English scientist working in the same field, met the same fate.

This brilliant picture of the accomplishment of modern medicine in improving public health by means of sanitation applied to the environment of large communities, and of the methods of preventive medicine applied to the individual citizen, is the obverse of a medal typifying the success of medical art which has a dull and unfortunate reverse side. The relation of preventive

medicine to the waging of war is not one of which the profession can be wholly proud. When the American Army of twenty-five thousand men was in Cuba in 1898 they lost less (four hundred and sixty-nine) men from wounds than were invalided from the diseases prevalent for years in military camps—dysentery, typhoid and from one of the scourges of the Tropics, malarial fever. The deaths from diseases were more than four times greater than the number dead from military casualties. As a matter of fact, the grouping together of soldiers in training or in field has always been the signal for the breaking out of epidemic diseases. This has proved in the past to be a certain check upon military activity and success, and many of the cases of typhoid and malaria which harassed the American troops in the Spanish-American War were contracted in the camps of the United States, and the deaths occurred without the victims leaving their native shore. In the Russo-Japanese War of 1904, the Japanese Medical Corps showed what improvement in sanitation could do to overcome the failures in medicine evident in the previous wars. Their greater efficiency in preventive medicine undoubtedly was a factor in fighting the greater numbers of the Russians to a standstill.

The World War of 1914-1918 demonstrated these facts with even greater clearness. The application of inoculation against typhoid fever, the use of antitoxin to prevent tetanus from infected wounds, vaccination against smallpox and the use of antitoxin for diphtheria, improved sanitation in regard to the supply of drinking water, disposal of sewage and a better per-

sonal hygiene of the individual soldier, did much to control the older forms of epidemic which had devastated armies in former times. The carrying on of these methods of public health became a difficult problem to organize when it came to the medical care incident to trench warfare. The transportation and feeding of troops in a trench exposed to continual bombardment was an easy problem as compared with the carrying on of local sanitation and hygiene. The trenches in Flanders and in France occupied both by the Allied Armies and by the Germans were a constant menace not only to the health of the armies but, as was efficiently proved, to the whole world. The presence of vermin, especially rats and the attendant fleas, and human parasites, as well as the possibility of a development of epidemic germ diseases, became an almost irremediable condition. Preventive medicine failed eventually to control the situation, and the infractions of the laws of health and hygiene necessitated by the herding together of several million men in a line of battle two hundred miles long intent only upon the legalized murder of one another finally brought about the explosion of an epidemic which had a great influence in ending the war.

The breaking out of influenza with its peculiar and very fatal type of pneumonia placed thousands of men in hospitals. The death-rate was high and unquestionably this condition of a serious and uncontrolled pandemic influenced the leaders on each side to worry about their own troops, for neither side would appreciate that a similar condition both of mental anxiety and of physical illness existed in the camps of their opponents. This

epidemic spread from the armies to the civilian population, from the site of warfare to the countries at war and to those of neutrals. Eventually it went around the world, carrying with it a tremendous mortality and causing a large number of deaths.

The World War reintroduced older methods of warfare which the nations using them had solemnly contracted should be entirely eliminated from war. The use of poison gas particularly was too successful not to be tried in spite of the sane and sober promises of nations at peace and their previous contractural agreements confirmed by solemn treaties. During the war there was much talk on one side and the other of their opponents having used cultures of disease germs to poison wells and in this way to spread disease among the civil population as well as in the armies of the apponents. It is hard to conceive that such diabolical procedures were even thought of, but it suggests the possible extent to which discoveries of scientific medicine can be put by insane or criminally minded nations.

The story of medicine up to the nineteenth century was emphasized by the recurrence of epidemics. Typhus fever which comes from the bite of an infected louse, and yellow fever which is the result of the bite of an infected mosquito, have existed in epidemic form as far north as New York City even as late as the first half of the nineteenth century. Asiatic cholera which is spread entirely by the contamination of drinking water by the excreta of patients ill with the disease was present in epidemic form in Europe and especially in Hamburg, Germany, in 1892. The endemic and epidemic ex-

istence of the plague in Europe up to the seventeenth century dominates the writings of medical leaders of that time, and Sydenham, Boerhaave and their predecessors were greatly influenced by these explosions of disease in formulating their ideas, both of diagnosis and of treatment of all diseases.

There exist in the world to-day two great epidemics, both of which are prominent and universal in distribution. Both may be acute but are usually chronic. One of them, tuberculosis, has always existed. The attack which has been made upon it within the last thirty years has had marked results. The improvement which has been secured will not be permanent unless this attack is continued as actively in the future as it has been practiced in the past. The appreciation that tuberculosis is contagious is as old as Galen. The fight against tuberculosis consists in the treatment of the individual and the endeavor to arrest the further progress of his disease. The keeping of the patient who is actively ill in comparative rest in a climate which is dry, protecting him from acute infections of all kinds, the careful administration of nourishing and easily digested food, will often bring to an end the active processes of his tuberculous infection. Such a patient will always have locked up in the seat of his old disease the germs in a quiescent state. His disease will be arrested, and he must then find a climate where he can live and work, but he must always be careful not to overtax his limited strength and power of endurance. The second method of attack consists in caring for the pre-tuberculous person, the individual who inherits a distinct tendency and lessened

resistance to the infection. This means the careful training and nourishment of the child in the endeavor that he may be able to increase the natural immunity which exists in his body in a form less well developed than that of a more normal individual.

The second great epidemic which now infests the world is that of syphilis. Because this disease is usually contracted through illicit sexual relations it has been placed through the prudery of our immediate ancestors upon the list of tabooed subjects never to be mentioned, always to be hidden from sight, hearing and even thought. The great freedom in discussing all things medical of the present generation has lowered the bars of this prohibition against the private and public recognition of syphilis. The interest of modern women in social service in the hospitals, in the economic and humanitarian work of the physician, has done much to bring this hidden medical scourge into public view. It can not but be for good in the end although many now living are frequently shocked at the conversation of their friends and acquaintances, for the name of Syphilus, the "hero" of the great medical poem by Fracastorius, published in Venice in 1530, is on the lips of many persons. The first appearance of the disease was at the siege of Naples in 1495. It was known to the Neapolitans as the French Disease, and by the French invaders as the Neapolitan Disease. It spread in virulent form over Europe and was given many names. The responsibility for its origin having been extended to various nations it was called Polish, German, Turkish, or Spanish as different nations tried to escape responsibility for its

existence. It is perfectly possible, as has been claimed, that it was imported from the countries of the Caribbean Sea by Columbus and his followers and that it took on increased virulence because it found a new and unprotected race of human beings upon which to strengthen and increase.

The disease is insidious. As soon as its acute stage is over it remains as a more or less permanent infection harassing and influencing the health of the individual sufferer for the rest of his life. Its contagious character is soon lost but it can be transmitted to the next generation from either parent when not infective to the present generation. The discovery of the hemolytic test by Wassermann has given the profession an accurate measure of its prevalence. It has been found that in America to-day fourteen per cent. of the whole population are infected. Many of these are not contagious and present no active symptoms. Many may have had the disease and can no longer transmit it by heredity, but it remains still a distinct menace to the health of the world.

It was a fortunate though inaccurate guess on the part of Paracelsus that the human body was made up of three elements, sulphur, salt and mercury, for these three mineral substances became valued drugs in the treatment of disease. The application of sulphur locally brought about the general elimination of the itch from the world. The medical profession has always been exposed to the insistent and rigid questioning of its patients. The layman demands even to-day from the physicians an exact opinion as to diagnosis of the

disease from which he is suffering, and the individual physician has deemed it necessary until quite recent years at least to make an attempt to meet this demand, and to cover up an ignorance of his own the physician has always had a universal diagnosis to offer. Such a universal diagnosis has varied with the fashions of the time. Before bacteriology was invented all continued fevers were malaria, which subsequently might be cured by quinine, or if not malaria they would "turn into" typhoid fever. Napoleon suffered from epilepsy and the diagnosis of his chronic neurosis was made by his personal physician, Corvisart, who was one of the great physicians of his time, as suppressed itch, for *la gale inaperçu* was used to cover a multitude of troubles which at the time were not immediately recognizable. At the present time *la grippe* holds this prominent notoriety.

Following Paracelsus, mercury was used in the form of metal, quicksilver, and of its various salts, especially the sublimate, to treat many diseases. It was used empirically in the new epidemic which was spreading through Europe and which came to be known as syphilis. It so happens that mercury and its salts have a truly specific action against the poison of syphilis, and until the twentieth century no better treatment was devised, although improved methods of administration were formulated.

Paul Ehrlich devoted the last year of his life to attacking this scourge. In his experiments with certain specific dyes in the treatment of trypanosomiasis in mice he found that if the doses were too small completely to cure the animal of his parasite that the parasites themselves became used to the remedy and were made per-

manently resistant to the drug. This power of disease germs to protect themselves against specific medication by drugs probably accounts for the failure of certain medicines to effect a cure in chronic cases of disease. Ehrlich conceived the idea that a drug might be found which would destroy in one large dose all the germs present in the body of a person ill of a disease. To find a drug which would have this specific action against the individual germ without destroying or injuring the individual cells of the body was a difficult problem but one which had behind it the active imaginative mind of a great scientist. Ehrlich entered into a long series of experiments to find such a *therapia sterilisans* against syphilis. He chose arsenic as the basis of his work and finally produced a drug which has been known as salvarsan and which was first introduced under the laboratory title of "606." The drug was found to have a distinctly bacteriocidal effect upon the Spirochæta pallida which had been discovered as the causative agent of syphilis by Fritz Schaudinn (1871-1906) in 1905. The remedy has proved far more useful and successful in the treatment of syphilis than any other that had previously been tried. Subsequent experiments developed a neosalvarsan which was more convenient in use, apparently equally valuable, and which did not possess so great a toxic influence on the tissue cells of the patient. The numerals 606 for salvarsan and 914 for neosalvarsan are simply identification marks used in the laboratory to distinguish a long series of drugs with which unsuccessful experiments had been made. This fact in itself indicates the thorough and long-continued endeavor which

Ehrlich undertook before success resulted from his labors. Such remedies can not be used with impunity for they have a distinct toxic effect in repeated doses. The work of Ehrlich in this effort to cure syphilis has been of the greatest service although it did not fulfill his ideal. Ehrlich's *therapia sterilisans* was not a possibility in syphilis although subsequent observation has proved it to be such in the case of the Treponema pertenuis, the parasite causing the tropical disease known as yaws.

XVI

OSLER

The Physician of the Twentieth Century

Medical Education

The education of the next generation of physicians has always been felt a duty by the profession. The original text of the oath of Hippocrates enjoins on each apprentice beginning his training in medicine to swear "that I will look upon him who shall have taught me this Art even as one of my own parents. I will share my substance with him and I will supply his necessities if he be in need. I will regard his offspring as my own brethren, and I will teach them this Art, if they would learn it without fee or convenant. I will impart this Art by precept, by lecture and by every mode of teaching not only to my own sons but to the sons of him who has taught me and to disciples bound by covenant and oath according to the law of medicine." Medical education began in the relationship of father and son or of preceptor and pupil. It was thus an intimate and personal contact which preserved the traditions and accumulated knowledge as no other method could even in the time of the written book, due to the latter's scarcity as a means of permanently recording accepted facts and new discoveries. The *asclepieia* pro-

vided such opportunities to individual teachers and were in no sense organized medical schools.

The Romans showed their ability for organization by providing halls for teachers of medicine and later by paying salaries for this service. It seems likely that the demand for army surgeons was a principal motive for this innovation which was developed under the Emperor Vespasian and his followers. The Romans built the first hospitals which also were largely for the medical care of the army, and both the hospitals and the teachers' auditoria were placed in the provinces and near the frontiers in such places as Düsseldorf, Nimes, Lyons, Marseilles and Bordeaux. The method of teaching, however, did not change from that of Aristotle and Hippocrates. The pupils accompanied their preceptors on professional visits and listened to theoretical lectures in the halls of medicine. It was much the same in the schools and hospitals of the East during the transition period from the third and fourth centuries up to the revival of learning in the fourteenth and fifteenth. These Eastern schools were conducted by the Nestorian Christians and the Persian physicians of the Moors.

During the early Renaissance the first subject to be taught was anatomy, which was presented by the professor who read from his pulpit-like desk a book of Galen or Avicenna while his demonstrator did the actual dissection on a table before the rostrum. If we can believe the frontispiece of the epoch-making book of the sixteenth century, that of Vesalius, that genius did his own dissecting and demonstrating before his class of students and visitors. In the fifteenth and sixteenth centuries medical education did not rise from the even

level of listening to the reading of a text-book by the professor who may or may not have added interest by personal comment on the text. The worship of precedent and authority was all controlling until Boerhaave (1668-1738) emphasized the clinical teaching of medicine at the bedside of those ill in hospitals in the early eighteenth century. In this new development he followed his predecessors in the University at Leyden where some clinical teaching has been practiced since 1636. Leyden completed the modern conception of a medical curriculum by opening the first university laboratory under the influence of Franciscus Sylvius (1614-1672).

The results of the preeminence of the School at Leyden were far-reaching, especially on the teaching of medicine in Anglo-Saxon countries. The primary result was the development of the Medical School at Edinburgh where for the first time all medical instruction, chemical, physiological, anatomical and clinical in medicine and surgery were combined in one institution. The second result was the foundation of medicine on the same firm basis in the American Colonies as a direct inheritance from Edinburgh. The pupils of the Scottish leaders, Cullen and the three Monros, founded the first hospitals in North America. The Pennsylvania Hospital (1751) and the New York Hospital (1773) were both started by Drs. Lloyd Zachary, Thomas and Phineas Bond in Philadelphia and by Drs. Samuel Bard, John Jones and Peter Middleton in New York to furnish clinical instruction for the new schools of medicine just begun in those cities. Medical education in the countries of Europe progressed in a satisfactory manner, and continuously France became celebrated for its clini-

cal teachers. England developed the system of undergraduate participation in the wards of its hospital schools, and Germany became famous for its scientific laboratories and the workers therein. In America the early promises of success were not fulfilled until the end of the nineteenth century when the best methods of all the systems of the European schools were adopted; until at the present day the methods of teaching medicine in American universities have become the equal of those given anywhere. The number of schools has been reduced from one hundred and sixty to eighty, and all but a few may compete for preeminence in friendly rivalry with their sister universities in Europe. The genius of the United States is akin to that of that earlier republic, Rome, and much stress is placed on organization. The belief that every error great or small can and should be regulated by law has multiplied the laws of the forty-eight United States until no one can understand or be cognizant of every variety of law. Medical education in the great American Republic is suffering to-day from over-regulation, and too great detail is prescribed in the forty-eight varieties of legal control by the states.

The medical student of to-day in America has his work ordered in a fixed program that presents the whole science and art of medicine in a logical sequence which demands that every subject having an influence on the interpretation of another shall have precedence in the curriculum prescribed by law. Such a curriculum is theoretically possible perhaps, but in practice it is impossible to accomplish. In the countries of Europe no such fixed routine exists, for the student is given a

wide latitude to arrange his studies for himself and to take what subjects he pleases in his own selected order. The American system compels a student to begin his education and end it in the same university. The foreign plan permits a considerable amount of migration, and this opportunity for travel from one university to another is highly prized and largely exercised by the students who may enjoy it. The actual experience of a student is, however, not very different in detail and method on both sides of the Atlantic. There is the fraternal bond linking together the undergraduate and his younger instructors which instils in the mind of the future medical practitioner early in his career a respect for the traditions and for the earnest work which are necessary for his success. The medical student of to-day is highly trained in the laboratory branches. He comes early into contact with patients who are ill both in the dispensary and at the bedside in hospitals, but his greatest teacher is the individual responsibility which is found in his work after graduation as interne or assistant in the hospital when personal control of patients is put in his hands and he is compelled to act on his own initiative. The modern physician trained in such a system has a broad point of view and is not a mere artizan working at a trade. He may devote himself entirely to the practice of his art, but he knows the ways of science and has practiced them. To continue to be successful he must be constantly studying and reading to learn the new advances which are made so frequently. He must be an artist who can utilize and apply the newest methods and most recent facts directly to the in-

dividual case which is under his care. His whole professional life must be one of study, for if he stops reading he will immediately begin to grow old professionally.

The aphorisms of the Father of Medicine must be remembered. If his "life is short" the modern physician must make it full of active participation in the labors of his colleagues, and if his "art is long" he must never cease to keep up with the procession along the road though he may tire by the way. If the "occasion is fleeting" he must be ever on the alert not to let it pass by without the opportunity for acquiring knowledge or for helping some person confiding in him for treatment and assistance toward a return to health or a relief from his suffering. If "experience is fallacious" he must store up in his memory his previous failures rather than his successes, for the avoidance of error is more important for the future than any servile attempt at a repetition of previous success. Success will remember itself, but error is apt to be forgotten. And finally if his "judgment is difficult" he must call always upon his previous experience, upon his store of knowledge and exercise an imagination which will develop new ideas and newer methods for the overcoming of new and old problems in the practice of the art of medicine. In the works of Hippocrates is to be found an aphorism concerning degrees of knowledge which has been translated by Littré: "There are, in fact, two things: to know and to believe one knows. To know is science, to believe one knows is ignorance." The modern practitioner in practicing his art should always bear in mind a

modern addition to this ancient aphorism: To know that one does not know is knowledge indeed. As Thomas Huxley wrote: "Next to being right in this world the best of all things is to be clearly and definitely wrong because you will come out somewhere. If you go buzzing about between right and wrong, vibrating and fluctuating, you come out nowhere."

The modern physician needs a hobby which can give him some instructive and interesting occupation outside of his professional life. During the past two years in New York a voluntary association of physicians has exhibited at the Academy of Medicine the results achieved in art by members of the profession. There were over one hundred exhibitors gathered from various parts of the United States. There have been physicians who have been very celebrated for their artistic work which has overshadowed their reputation as medical men. F. Seymour Hayden, the etcher, was a surgeon of reputation before he was known as an artist. He had another hobby which he shares with many physicians. He was an angler, and it was his devotion to the pastime of Izaak Walton that led him into etching. LeRoy M. Yale and Arpad G. Gerster were etchers of repute as well as practicing doctors in New York City. The pursuit of literature has claimed more physicians perhaps than any other outside activity. S. Weir Mitchell, of Philadelphia, who did so much for the rational treatment of neurasthenic conditions, made notable contributions to American literature. Oliver Wendell Holmes has left a permanent reputation by his writings rather than by his teaching as professor of anatomy at Harvard. It is

no new thing for physicians to be prominent in literature. Richard Bright wrote a book of travels through southeastern Europe; John Bell, of Edinburgh, wrote a book of his European tour entitled *Observations in Italy;* Schiller was trained as a physician; and Haller, Werlhof and Jenner, the former a medical philosopher, were poets. Robert Bridges, the present poet laureate of England, is a physician. Goethe was a trained botanist who took a broad view of all science and added much to the early ideas of evolution in his studies of the anatomy of the vertebrate skull. In the sixteenth and seventeenth centuries medical facts and new discoveries were often published in verse. Fracastorius' treatise on syphilis, Garth's criticism of the apothecaries and support of the dispensaries were presented to the world in this form. The writings of Sir Thomas Browne, *Vulgar Errors* and *Urn Burial,* have almost as high a reputation as his *Religio Medici.* The great teacher of surgery of the nineteenth century in Vienna, Theodor Billroth wrote verses. Many physicians have shown an artistic temperament and many have been trained musicians, several of whom have become performers of local reputation; Auenbrugger composed at least one opera.

There is a tendency to-day to isolate the investigator from the practitioner. This may add something to the improvement of scientific results but it is not an unmixed benefit. There is a happy mean by which every physician can keep a certain interest in the science while he devotes himself to the practice of the art of medicine. It is a mistake to eliminate the practitioner from the office of teaching in the university and to bring into

the medical clinic only those physicians who have devoted themselves to work in hospital and laboratory. The craze for this latest fad seems to be waning. It should never be forgotten that there is a science of medicine and also an art, and that is the latter to which the large majority of medical graduates will devote their lives.

William Osler

It is appropriate that the concluding chapter of the story of medicine as told at the present day should deal with William Osler. The name of Osler is linked with no epoch-making discovery such as that of the circulation of the blood, the introduction of a new science such as bacteriology, or the relief of humanity from some great scourge such as smallpox. But Osler represented at the beginning of the present century the fruit of all that was best which had gone before in medical art, science and tradition. His life covered the seventy years which is the period of the greatest development that has ever been known in the history of medicine. Surgical anesthesia was three years old when he was born. Virchow published his cellular pathology when Osler was ten. Bacteriology and its sequel aseptic surgery grew into the commanding position of to-day while he studied medicine and began his career as a teacher at twenty-five. William Osler played his own part and has left his impress on the growth and development of the clinical medicine of the modern civilized world. He was the typical physician of the twentieth century. He

was born in 1849, one of the nine children of an Episcopal clergyman, at Bond Head in the then sparsely settled Upper Canada. His youth was not remarkable; he was a good cricketer and often the instigator of the pranks in which boys collectively like to indulge. Inspired by his teacher, an Episcopal clergyman, Father W. A. Johnson, he developed early an interest in zoology and natural history, often spending his time in the collection of zoological specimens. Undecided for a time as to whether he should enter the Church or study medicine, he finally settled upon the latter and enrolled at the University of Toronto, transferring later to McGill University at Montreal.

The medical curriculum at that time was of course quite limited, and students obtained a great deal of their education under the preceptorship of some older physician. Osler's preceptor was Dr. James Bovell, a country practitioner of broad culture with an interest in zoology, botany and geology. He inspired Osler with a scientific spirit and a wide interest in many subjects in addition to medicine. Upon completion of his medical course, Osler went abroad for a period. He visited London, Berlin and Vienna, taking courses under celebrated physicians, especially Virchow, and "walking the hospitals." Frequently while abroad he wrote informative descriptions and comments upon medical progress in Europe which appeared in the Canadian medical journals.

During one winter he took up work in the laboratory of the celebrated English physiologist, Burdon Sanderson. While there he shared in the discovery and for

the first time described the globoid bodies in the circulating blood which are called blood platelets; these have since been found to influence the clotting of the blood. At this time Osler was undecided as to whether or not he should take up ophthalmology, the specialty of the diseases of the eye, as a career. But young Osler's ability had been recognized by the members of the McGill faculty, particularly by its dean, R. Palmer Howard. He was therefore offered the professorship of the Institutes of Medicine at McGill University which included the subjects of pathology and physiology. At twenty-five he became an important member of the faculty of one of Canada's best medical schools.

In this way the career of one of the most widely known physicians of all time began; a career crowned with success and acomplishment, and with the universal respect and affection of his fellows. In later years Osler attributed his success to his industry. The master word of medicine, he said, was work. That his own industry was prodigious there can be no doubt. Physically he was gifted with seemingly tireless energy. He had that fortunate faculty or mental habit of thinking to useful purposes at all times. He had the habit of jotting down in a note-book which he carried with him thoughts that obtruded themselves at inopportune times but were worthy of returning to later. This suggests in Osler something of the type of man who lives within himself. Nothing could be less true. He loved companionship, was eminently sociable and interested in humankind. His genial courtesy and friendliness and generosity attracted all with whom he came in contact.

Osler influenced medicine by no revolutionary discovery of his own, but by espousing, explaining and teaching all that was best in medical thought of his day he exercised an important influence in the betterment of the knowledge of the average physician. Successively professor at four universities he left his impress on a large number of students in the three largest English-speaking countries. At McGill he organized courses in physiology and pathology and obtained for his laboratory a sufficient number of microscopes to enable each student to use one in his studies. At that time such equipment was not always available even in the best medical schools. He experienced one of the great epidemics of the nineteenth century while in Montreal. Owing to the neglect of preventive vaccination, smallpox broke out in a virulent form in that city. For the rest of his life William Osler was peeminent in teaching the most modern methods of preventive medicine. He was a leader in advocating the great advances in the control of public health, which is one of the outstanding advances of the medicine of the twentieth century.

Ten years after accepting the lectureship at McGill the chair of Professor of Medicine became vacant at the University of Pennsylvania. In a discussion of possible candidates S. Weir Mitchell said of Osler, ". . . he has every social need; his age is thirty-five. He has won distinction as an investigator and worker . . . and as to his competency as a teacher, if anyone is to be believed, he must be an unusual instructor."

This chair was offered Osler and was accepted much to the regret of the faculty and students at Montreal. At

Philadelphia he worked industriously at teaching, at hospital work at the bedside, in the autopsy room, and in writing, but his stay in Philadelphia lasted for only five years. A Quaker named Johns Hopkins had a short time before willed what was then considered a very large endowment for the founding of a university which was to include a medical school and hospital. Osler was offered and accepted the position of Physician in Chief and Professor of Medicine at the new institution. He accepted that he might have the opportunity to build up his department in his own way unhampered by tradition or other interference. At thirty-nine he began the most fruitful period of his career. The other chairs in the medical faculty were filled with men who also were to become noted in their respective branches of American medicine: William H. Welch in pathology, William S. Halsted in surgery, and Howard A. Kelly in gynecology.

At Johns Hopkins Osler instituted a notable innovation in medical teaching which was one of his most important contributions to medical education in America. At this time medical students gained a theoretical knowledge of medicine from their lectures and text-books, but except in the best schools they had no first-hand or practical experience with disease until they began to practice either as hospital internes or in private work. Osler adopted the English system of clinical clerks and surgical dressers and brought his students into the wards and clinics where they were instructed in the methods of examining and treating patients. To assist him in his hospital work he introduced another innova-

tion, and following the hospital system of Germany, he appointed a group of younger graduates as resident physicians. Upon these and the undergraduates he exercised one of his greatest gifts—that of inspiring others to productive work. Many of these students and assistants who were to achieve a high rank in the profession owed much of their success to Osler's inspiration. This new plan of organization of a medical clinic has been adopted in every first-class medical school and was the last development to place American medicine on a par with that of the rest of the world.

While at Johns Hopkins Osler wrote his text-book, *The Principles and Practice of Medicine*. In a single volume of some thousand pages Osler defined, gave the known causes, the symptoms, the pathological findings, the treatment and often a brief historical note, of all known diseases with the exception of a few very rare ones. The book was so comprehensive, at the same time so clear and concise that it met with immediate success, and for the rest of his life Osler was occupied with the triennial task of revising and bringing it up to date. Hippocrates was the inspiration if not the author of the first known book on medicine, Osler was the author of the last which is still the standard text-book in every English-speaking university. This book was translated and published in German, French, Spanish and Chinese. It became the accepted authority for medical students, and general practitioners were quick to adopt it as an instructive and helpful source for reference. Some one has said that Osler had succeeded in making a scientific treatise literature. The profession to-day remembers

Osler the man; to future generations he will always be a Book.

One influence of the text-book was unexpected. It came into the hands of one of Mr. John D. Rockefeller's philanthropic advisers. This layman found it interesting enough to read it in its entirety. It is true that Osler, honest as he was, found it necessary in the majority of diseases to confess that there was no specific treatment and that the Hippocratic method of nursing and assisting nature as much as possible must be relied on. The great need for institutions devoted to research on these lines was presented to Mr. Rockefeller who became interested in the idea, with the result that the Rockefeller Institute for Medical Research was founded.

Osler exerted an influence on his profession through this text-book and also to a great degree through the various medical societies and associations. He was in demand as a speaker and was constantly reading papers at their meetings or writing editorials for their journals. Many of Osler's addresses have been collected and form a series of essays of great literary charm. The richness of Biblical, mythological and historical references reflect the broad culture of the author. As an example one may quote parts of a discussion of the influence faith plays in healing: "A third noteworthy feature of modern treatment has been a return to psychical methods of cure, in which *faith in something* is suggested to the patient. After all, faith is the great lever of life. Without it man can do nothing; with it, even with a fragment as a grain of mustard seed, all things are pos-

sible to him. Faith in us, faith in our drugs and methods, is the great stock-in-trade of the profession. In one pan of the balance put the pharmacopœias of the world, all the editions from Dioscorides to the last issue of the United States Dispensatory; heap them on the scales as did Euripides his books in the celebrated contest of the Frogs; in the other put the simple faith with which from the days of the Pharaohs until now the children of men have swallowed the mixtures these works describe, and the bulky tomes will kick the beam."

The successful physician of to-day has a sense of humor which is rough and Gargantuan in his student days but which becomes toned down as he comes in touch with the serious side of life, and William Osler was no exception. Many of his jokes were perpetrated through the mail in the form of fake contributions to his friends, the editors of various medical journals. His favorite *nom de plume* for such nonsense was Egerton Yorrick Davis, M. D. Ex U. S. Army Caughnawauga, P. Q. Some of his jokes slipped into medical literature as certified truth and Osler soon dropped the acquaintance of his "friend" Davis and ceased to "cut up" in this fashion. One of Osler's addresses brought him unmerited notoriety. The occasion was his farewell address at Johns Hopkins. In this he said: "I have two fixed ideas well known to my friends, harmless obsessions with which I sometimes bore them, but which have a direct bearing on this important problem. The first is the comparative uselessness of men over forty years of age. This may seem shocking and yet read aright, the world's his-

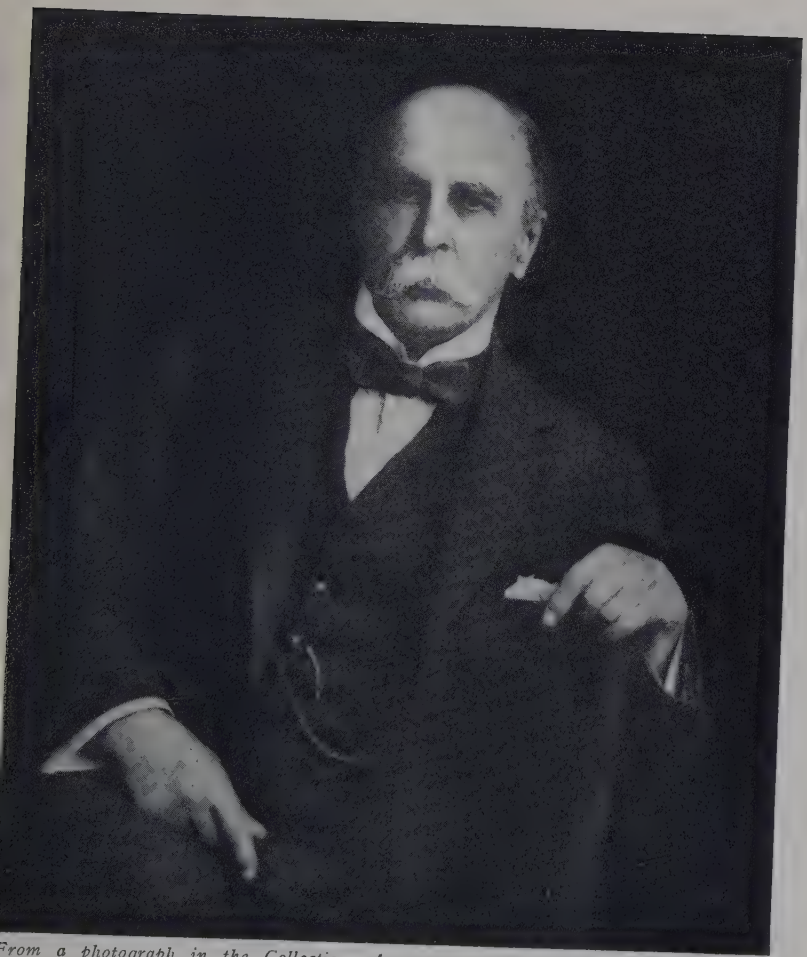
tory bears out the statement. Take the sum of human achievement in action, in science, in art, in literature—subtract the work of the men above forty, and while we should miss great treasures, even priceless treasures, we would practically be where we are to-day. . . . My second fixed idea is the uselessness of men above sixty years of age, and the incalculable benefit it would be in commercial, political, and in professional life if, as a matter of course, men stopped work at this age." He then went on in a semi-humorous vein to refer to a novel of Anthony Trollope's describing a college which men entered at sixty for a year's period of contemplation before their peaceful departure by chloroform. "Whether Anthony Trollope's suggestion of a college and chloroform should be carried out or not," he said, "I have become a little dubious, as my own time is getting so short." Unfortunately, the press during a time of lull in actual news scented a sensation in his remarks and soon the head-lines appeared saying that "Dr. Osler Recommends Chloroform for Men of Sixty." This precipitated a wide-spread discussion often heated and even bitter by those of whom many had never read what he had actually said. A new phrase—to oslerize—was added to the language indicating the extinction of men of sixty. Osler recognized that he was the victim of misguided reportorial zeal, that explanations under the circumstances were useless, and let the storm blow itself out.

This address was given at the time of his leaving Johns Hopkins to accept the Regius Professorship of Medicine at Oxford. The latter position offered much

less opportunity for teaching and clinical work than had his position at Johns Hopkins, but there were many things about it which appealed to him. Osler was then fifty-five. In addition to his other work he was frequently summoned as a consultant and in fact was constantly being called to all parts of the country. An Englishman by birth, the highest reward in the English profession naturally appealed to him.

He soon assumed an influential position in English medical affairs. He found the life at Oxford thoroughly congenial and soon took great interest in the Bodleian Library. He had for a long time been an enthusiastic collector of rare books and had done much for the libraries of the universities with which he had been connected. His interest centered largely in medicine and early medical authors, and he became deeply interested in the books related to medical history and was a frequent writer on the subject.

At forty-two Osler married Mrs. Grace Revere Gross, the widow of a Philadelphia physician. The Osler household was noted for its hospitality to all and every visiting physician. During the war when so many Canadians and Americans were passing through England, the sons of many of their friends found the Oslers' door constantly open to welcome them, and the house came to be known as the Open Arms. The war terminated Osler's plans for a more leisurely life. He immediately became engaged in advising in matters of medical organization and in acting as consultant to numerous military hospitals. Many Canadian parents were comforted when, in answer to frantic inquiries con-



From a photograph in the Collection of Archibald Malloch, M.D.

Figure XXXII

OSLER

cerning sick or wounded sons, they received a cable containing the words, "Seen by Osler."

The loss of his only son, Revere, in action in the World War removed a very promising mind from the world and undoubtedly hastened the father's death. The son was an enthusiastic lover of literature, a collector on his own individual lines of the books of the seventeenth century. Lady Osler has presented her son's library to Johns Hopkins to form a Tudor and Stuart Club that the personality of her son may prove to be an influence on the life of the undergraduates of that university. Young Osler had just begun at Oxford his preparation for a medical career. He was an ardent angler and this library contains among other books a small but choice collection of the works of Edmund Spencer and of Izaak Walton which will undoubtedly become celebrated among the collections of the world. At the death of his son, Osler was sixty-eight and was to live two years longer. He continued his routine of duties in the hospitals for the ill and wounded, finding solace in the interest of cataloguing his wonderful library. He died after a protracted attack of pneumonia in 1919. Lady Osler survived him for nine years during which she carried on the Osler tradition in their home in Oxford which continued to be the Mecca for physicians from the United States and Canada when visiting England. A photograph of Sir William Osler from the Collection of Dr. Archibald Malloch, which was taken on his seventieth birthday, is reproduced in this volume as Figure 32.

The work of William Osler in literature always had

a medical bearing, and his high ideals and clear entertaining style of writing made him known in as wide a circle in the literary field as in the medical. He added much to medical knowledge both by his own labors and by those of his assistants stimulated by him. He presented his philosophy of life in a short essay called *Æquanimitas,* which should be read by every young physician. Osler's charming personality, his learned and entertaining conversation, tied to him every younger man who had ever worked with him, and most of those who had ever met him, with a personal devotion and enthusiasm which is attained by very few men of any profession. He was knighted shortly after his arrival in Oxford, and as Sir William Osler became a prominent factor in the broad society of scientific and medical men of London, and the universities. His love of literature made him a collector, and he specialized on the works of Sir Thomas Browne and made a famous collection of the *Religio Medici.* His books were left by will to his home university, and McGill University is the happy possessor of this lasting monument to the personality of William Osler.

Osler inspired confidence and affection in his patients, and brought with him to the sick-bed resourcefulness, sympathy and the assurance of help. His reputation gained for him a wide public audience, and in this way he was able to exert an important influence in matters of public health. In the campaign which has been waged so successfully against tuberculosis by means of public education Osler's pen and voice played a willing and useful part. In his time Pasteur founded the science of

bacteriology, Lister introduced the method of aseptic surgery and Virchow announced a new conception of pathology. These and many other important, if less significant, advances caused rapid changes in medical practice. Osler was quick to understand and grasp the significance of these changes and, exercising his great gifts as a teacher, explained them to his students through personal instruction and to the profession at large through his text-book. His intellectual endowment was such that he could achieve greatness in his profession and at the same time interest himself in a variety of subjects.

William Osler deserved the title of most beloved physician of his time, and to him in all justice may be applied the tribute of Robert Louis Stevenson to the physician: "There are men and classes of men that stand above the common herd: the soldier, the sailor, and the shepherd not infrequently; the artist, rarely; rarelier still the clergyman; the physician almost as the rule. He is the flower (such as it is) of our civilization; and when that stage of man is done with, and only remembered to be marvelled at in history, he will be thought to have shared as little as any in the defects of the period, and most notably exhibited the virtues of the race. Generosity he has, such as is possible to those who practise an art, never to those who drive a trade; discretion, tested by a hundred secrets, tact, tried in a thousand embarrassments; and what are more important, Heraclean cheerfulness and courage. So it is that he brings air and cheer into the sickroom, and often enough, though not as often as he wishes, brings healing."

THE END